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THE DISTRIBUTION OF THE GENUS CYCLOPS IN THE VICINITY OF HAVERFORD, PENNSYLVANIA.

BY REYNOLD A. SPAETH.

The original purpose of this paper was, after the notes and observations of two years had been collected, to prove that by a careful and regular study of the water from a single locality, many of the forms of the *Cyclopidæ* which are now considered rare would be found to be quite abundant, at least at certain seasons of the year. Owing to unforeseen circumstances, this purpose had to be abandoned in part, and although all the forms recorded in this paper have been taken from a single small pond in the vicinity of Haverford College, the records of monthly abundance or rarity of the different species are not complete. Certain species, notably *C. varicans, C. fimbriatus* var. *poppei,* and *C. phaleratus,* appear far more abundantly in the spring from the middle of March to the end of May. *C. prasinus* I have found in the greatest numbers in September and early October collections. *C. albidus, C. viridis* var. *insectus,* and *C. serrulatus* do not vary so noticeably in the collections, while *C. fuscus* is the most unvarying species of the genus, a few being found in the water taken the year round.

In his paper of '97, E. B. Forbes has made a most excellent revisional study of the North American *Cyclopidæ.* His work has simplified investigation for all future workers in this field, and his very careful and excellent observations can hardly be overestimated. I have followed his system of subgenera to avoid confusion.

Cragin's paper of '83 has scarcely received due credit from the investigators who have followed him. His drawings show considerable accuracy of detail and very few of the important structural features have escaped his notice.

Marsh's work has been rather more of a plankton study than one of individual structure. Brewer's paper of '98 lays considerable emphasis on feet-armature, which is now generally considered a variable feature and not a reliable character for specific distinction.

Miss Byrnes' recent paper of '09 is somewhat confusing. Rather unfortunately she has reverted to Herrick's varietal names of *C. signatus*, has credited Forbes with both *C. bicuspidatus* Claus and *C. serrulatus* Fischer in her list of species studied, and has confused

C. bicolor Sars with *C. varicans* Sars. Many of her drawings, however, are excellent, and she has furthermore presented all figures on the same scale, which is of value in a comparative study of the species. Her chief source of information has apparently been Herrick, whose work, while remarkable, considering the number of species described, is, owing to its large field, often misleading and at times quite incorrect. She has neglected both Schmeil and Forbes—the most complete modern works on the subject. Her most careful study has been on the armatures of the four pairs of swimming feet, which, while interesting in showing the variations that occur, are not sufficiently constant characters to warrant a deduction of general conclusions.

E. B. Forbes was the first American investigator to lay much stress on the importance of the shape of the *receptaculum seminis.* He was convinced by Schmeil's work of '92 that it was the most important character for specific distinction. Its shape, while often somewhat obscure, varies very little, and the same general outline is preserved in all members of the same species. This outline is effected largely by the number of spermatozoa contained in the receptaculum. Other important distinguishing characters are the number of female antennal segments, the length of the first female antennæ, hyaline plates and sensory hairs and clubs, armature of the stylets (variable in some species), and the shape and armature of the fifth foot.

The number of female antennal segments is usually quite constant. Of the specimens from this locality, *C. phaleratus* and *C. varicans* were the only exceptions to the rule. The former may have either ten or eleven joints and the latter eleven or twelve. In the plate of *C. varicans* I have shown only the eleven-jointed form of the first antennæ, as this seems to be a winter transitional stage, though such individuals were all sexually mature. The twelve-jointed form did not appear until the April collections. The length of the female first antennæ varies remarkably in *C. serrulatus,* but in all species having antennæ of less than twelve segments, it is quite constant. Hyaline plates vary very slightly as to their edges. Minute serrations occasionally appear or are absent, notably in *C. prasinus.* Sense-clubs and hairs are constant features.

The armature of the stylets and their proportions are constant in some species, as *C. modestus, C. varicans,* and *C. phaleratus.* In others, as *C. bicuspidatus* and especially in *C. serrulatus,* the variation is very great.

Forbes considers the armature of the swimming feet "of considerable value in certain cases, and constant as a rule;" that "the general character with regard to strength, etc., may usually be relied upon; but I have often seen in a single specimen all the gradations between spines and setæ, and it would be impossible from this character to say which of the two names should be applied." The more I have worked out the armature of the swimming feet, the more I am convinced that a constant standard cannot be obtained for such an armature for all members of the same species. The following table is an illustration of the confusing results obtained in attempting to establish a standard swimming-feet armature for *C. phaleratus.*

CASE NUMBER 1.

First pair—outer ramus, three spines, five setæ; inner ramus, one spine, four setæ.
Second pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

CASE NUMBER 2.

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

CASE NUMBER 3.

First pair—outer ramus, four spines, five setæ; inner ramus, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—(right) three spines, five setæ; inner ramus, one seta, two spines, two setæ.
Fourth pair—(left) four spines, four setæ; inner ramus, one seta, two spines, two setæ.

The above cases show a variation in both outer and inner ramus of the first pair, in the outer ramus of the second pair, and the outer ramus of the fourth pair. The case of a spine becoming a seta as in the outer ramus of the fourth foot of Number 3 right and Number 3 left is not as unusual as the appearance of an extra spine, as on the outer ramus of the first pair of Number 3 compared with the corresponding ramus of 1 and 2. In some species the armature is considerably more constant. In *C. modestus*, for example, it rarely varies at all, specimens from widely separated localities showing an identical arrangement of both spines and setæ. After the examination of a great many specimens of a number of species, I have concluded that unless there are very distinct differences in some of the other important distinguishing characters, a slight variation in swimming-feet armature is not sufficient proof for establishing a new species or even a variety.

The fifth foot, both in armature and shape, is constant as a rule. There are slight variations occasionally in the shape of the segments and comparative lengths of spines and setæ. In a single case I have found a mature female of *C. viridis* var. *inseetus* with an extra completely developed seta on the distal segments of both fifth feet. This very unusual form is now in the collection of C. D. Marsh.

The *receptaculum seminis* has already been mentioned. In preserving specimens it is advisable to use a 1 per cent. solution of formalin to avoid contraction and distortion of this organ.

All of the plates have been drawn from life. The movements of the living animals may be readily overcome by the use of a 1–1000 parts solution of chlorotone. This I have found to be very convenient and all danger of flattening and distorting the outline of specimens may be thus avoided. By this method the same individual may be repeatedly used, as the animal recovers a few moments after having been replaced in fresh water. Care must be taken that the solution of chlorotone does not become concentrated by evaporation, in which case the animals are killed by its too violent effects.

The work in this paper covers a period of three years. All of the species described herein have been taken from a single pond of less than one acre area. The *Copepoda* having been largely neglected in this part of the country, it is interesting to note the presence of some of the more unusual forms, as *C. varicans, C. fimbriatus* var. *poppei*, and several others. I am greatly indebted to Dr. C. D. Marsh for his identification of specimens and his general interest and assistance throughout the period of study. My thanks are also due Mr. E. B. Forbes and Dr. H. S. Pratt. The latter, through his unfailing personal interest and encouragement and by placing the very best of the laboratory equipment at my disposal, is largely responsible for the existence of this paper. I gladly take this opportunity to acknowledge also the assistance of Mr. J. Ashbrook in collecting material.

Genus **CYCLOPS** O. F. Müller.

Subgenus CYCLOPS Claus s. str.

Cyclops bicuspidatus Claus. Pl. II, figs. 1–5.

Cyclops bicuspidatus Claus, '57, p. 209.
Cyclops pulchellus Sars, '63, pp. 246, 247, pl. XI, figs. 6 and 7.
Cyclops navus Herrick, '82*a*, p. 229, pl. V, figs. 6–13, 15–17.
Cyclops thomasi Forbes, '82*a*, p. 649.
Cyclops bicuspidatus Schmeil, '92, pp. 75–87, pl. II, figs. 1–3.
Cyclops minnilus Forbes, '93, p. 247.
Cyclops serratus Forbes, '93, pp. 247, 248.
Cyclops forbesi Herrick and Turner, '95, p. 104.
Cyclops navus Brewer, '98, p. 133.
Cyclops pulchellus Brewer, '98, pp. 133, 134.
Cyclops bicuspidatus Lilljeborg, '01, pp. 11–14, pl. I, figs. 12–17, pl. II, fig. 1
Cyclops pulchellus Byrnes, pp. 24, 25, pl. X.
Cyclops bicuspidatus Byrnes, pp. 25, 26, pl. X.

Synonymy and Distribution.—In his discussion of the synonymy of this very variable and widely distributed species, Forbes has cleared up the question of *C. thomasi* Forbes, *C. navus* Herrick, *C. minnilus* Forbes, and *C. serratus* Forbes = *C. forbesi* Herrick. He finds, after a careful comparative study, that they should all be considered as slight variations of the type *C. bicuspidatus,* but the differences are not sufficient to warrant the varietal names. Schmeil has also discussed the question at great length. He does not consider *C. thomasi* Forbes nor *C. navus* Herrick of specific value, since the latter is only a variety of *C. thomasi* Forbes. Brewer has described, as *C. navus* Herrick and *C. pulchellus* Koch, two species of cyclops from the vicinity of Lincoln, Nebraska. His descriptions of the rudimentary and swimming feet show that he was dealing with slightly different specimens of *C. bicuspidatus* Claus. As *C. pulchellus* Herrick and *C. bicuspidatus* Forbes, Miss Byrnes has described examples of *C. bicuspidatus* Claus from Long Island. Her descriptions of the swimming feet and her drawings of the *receptaculum seminis* show very conclusively that the two forms both belong under this specific name. The variation of the single seta on the fifth foot is frequently encountered in the species. The form of the fifth foot in what she describes as *C. bicuspidatus* Forbes is very interesting, for Forbes has found it but once and on that occasion from Woods Hole, Mass. It corresponds exactly with the European forms and with the representatives of this species from this locality.

C. bicuspidatus Claus is very widely distributed over the United

States. Forbes states that "it has been found in Massachusetts and Wyoming and in all the intervening territory," and further that "it is the commonest Cyclops in the Great Lakes." Miss Byrnes has recently found it to be a common form in the Long Island waters. I have noted that it occurs very abundantly in one of the large streams in this vicinity, but in the small pond from which I have taken every other species described in this paper I have found but a single specimen.[1]

Specific Description.—In the specimens of *C. bicuspidatus* Claus from this vicinity, the lateral angles of the cephalothorax are very prominent, as in the "specimens from the far west" (Forbes). The first thoracic segment is a little more than half the length of the entire cephalothorax (Pl. II, fig. 1). The posterior borders of all the thoracic segments are smooth.

The first abdominal segment (Pl. II, figs. 1 and 5) is unusually expanded, laterally, on the anterior side of the suture. It is about as long as the remaining three abdominal segments. The posterior margins of the first three abdominal segments are finely serrated (Pl. II, fig. 5). The fourth segment has the usual row of spinules on its posterior margin (Pl. II, figs. 1 and 2).

The stylets (Pl. II, fig. 2) are more than twice as long as the last two abdominal segments. Their length is about six times their width and they are frequently slightly out-curved. The above proportions hold good only in the cases of the specimens examined. They vary considerably in different localities. The lateral spine is inserted at the beginning of the posterior third of the ramus, and at a distance of about one-quarter of the length of the stylet from its insertion point there is always present a minute lateral comb of spinules (Pl. II, fig. 2).. Of the apical setæ, the outermost is heavy, finely plumose, and about as long as the delicate inner seta. The longer of the two prominently developed setæ is about equal in length to the abdomen and twice that of the shorter seta. They are both delicately plumose.

The first antennæ of the female (Pl. II, fig. 1) are seventeen-jointed and terminate at the end of the first thoracic segment. At the distal end of the twelfth segment there is borne an unusually long, spear-shaped sense-club (Pl. II, fig. 3). The setæ are all quite short and plumose for the most part. The terminal segments bear no hyaline plates and the last three gradually increase in length to the end.

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[1] In late March and April, 1910, collections in the vicinity of Cambridge, Mass., this was by far the most abundant form.

The armature of the swimming feet is as follows:

First pair—outer ramus, two spines, four setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, three spines, four setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, four setæ; inner ramus, one seta, two spines, two setæ.

The fifth foot (Pl. II, fig. 4) is two-segmented, the basal segment being about as long as broad and bearing a plumose seta on its outer distal angle. The distal segment is cylindrical, about twice as long as wide, and bears a long plumose seta and a short, thick spine. For this spine is often substituted a longer seta-like form, though that is not the regular armature in the local specimens.

The *receptaculum seminis* (Pl. II, fig. 5) consists of two divisions. The anterior portion extends as a low arch across the segment. The posterior division is bag-shaped and reaches a point half-way to the posterior margin of the first abdominal segment. Its anterior border branches out abruptly on either side along the suture. The porus is situated on the median line, between the lateral angles on the suture.

The egg-sacs are unusually large and are carried at a considerable angle from the body. Forbes gives the size of this species as 1–1.4 mm. Schmeil gives 1.3–2 mm. for the European forms. The specimens from this locality average about 1.5 mm.

The color of *C. bicuspidatus* is generally a very pale shade of yellow. Often individuals appear to be quite colorless. The dorsal surface of the thorax, especially the anterior portion, usually has a peculiarly shiny appearance.

The last characters for the distinction of this species are its slim form, the shape of the fifth feet and the *receptaculum seminis,* and especially the small lateral combs of spinules on the outer sides of the stylets.

Subgenus MARCOCYCLOPS Claus.

Cyclops fuscus Jurine. Pl. I.

Monoculus quadricornis fuscus Jurine, '20, pp. 47, 48, Taf. II, fig. 2.
Cyclops signatus Koch, '38, Heft 21, Nr. 8.
Cyclops coronatus Claus, '63, pp. 97–99, Taf. II, fig. 16 and Taf. X, fig. 1.
Cyclops signatus var. *coronatus* Herrick and Turner, '95, p. 106, pl. XV, figs. 1–4.

Cyclops fuscus Schmeil, '92, pp. 123–127, 136–140, pl. I, figs. 1–76; pl. IV, fig. 16.
Cyclops fuscus Jurine, Marsh, '95, pp. 16, 17, pl. VI, figs. 5, 7, and 11.
Cyclops signatus var. *coronatus* Herrick, Brewer, '98, pp. 129, 130.
Cyclops fuscus Jurine, Lilljeborg, '01, pl. III, figs. 12–15.
Cyclops signatus var. *coronatus* Herrick, Byrnes, '06, pp. 193–200, pl. VII, figs. 1–6, pl. VIII, figs. 1–3.
Cyclops signatus var. *coronatus* Byrnes, '09, pp. 9, 10.

Synonymy and Distribution.—In his discussion of the differences between this species and the closely related *Cyclops albidus* Jurine, Dr. Schmeil has proven not only that we are dealing with two distinct species, but also that Jurine was the first investigator to distinguish these two. It is only right, then, that Jurine's names should stand and that Koch's *Cyclops signatus* give way to (1) *C. fuscus* and (2) *C. albidus* Jurine. In spite of Schmeil's careful proof, several of our American investigators have clung to Herrick's varieties *tenuicornis* and *coronatus* of *C. signatus* Koch. C. D. Marsh accepted Schmeil's proof in his paper of '95. Even after the publication of Forbes' paper of '97, in which he abandoned Herrick's terms for those of Jurine, Brewer in '98 and Miss Byrnes in '06 and again in '09, have reverted to Herrick's varietal names.

In speaking of the "two varieties," *coronatus* and *tenuicornis*, Brewer states that "the real differences between them are confined to the seventeenth joint of the antenna and the caudal setæ." He then continues: "The difference between their first cephalothoracic segments and their furcæ is hardly distinguishable." On p. 136 of Schmeil's monograph there is a table of "the most important distinguishing characters" of the two species in question. Of the *eleven* "important characters" mentioned, Brewer has noted four, and no mention is made of such important features as the *receptaculum seminis* and the sense-club (present or absent) on the twelfth antennal segment.

It is quite evident that Miss Byrnes has overlooked the more important distinguishing differences between the two species. In her recent paper, *The Fresh Water Cyclops of Long Island* ('09), in spite of the carefully tabulated proofs of Schmeil in Germany and the acceptance of his views by both Marsh ('95) and Forbes ('97), Miss Byrnes has clung to the obsolete name of *C. signatus* Koch and attempts to revive Herrick's varietal name *coronatus* and Richard's(?) *annulicornis.* In a foot-note (on p. 9) she states: "I have used the more recent name *C. signatus* var. *coronatus* instead of the older name *C. fuscus* Jurine, because it expresses more clearly the evidently close relationship that exists between *C. signatus* var.

coronatus and the allied form *C. signatus* var. *annulicornis*, called *C. albidus* by Jurine."

It is quite evident that Miss Byrnes has not had Dr. Schmeil's exhaustive work on the *Cyclopidœ* of Germany at hand. He has shown conclusively (129, 130 and 137–140) that by right of priority Jurine's names should stand. No matter how "close" the "relationship" between the two forms in question, Miss Byrnes is hardly justified in using "the more recent" name. In her description of *Cyclops signatus* var. *coronatus* (p. 9) she states that this form has "serrations in the hyaline plate on the two distal segments of the antennæ" and, furthermore, that "the notches in the hyaline plate of the antennæ form gradually and may or may not be present. In fig. 4 they are seen on the last segment only." The first statement I am unable to verify, nor do any of the investigators mention a serration of the "two distal segments of the antennæ." They are always present in the hyaline plate of the *distal* segment in adult forms. In the immature forms the plate on the distal segment of the antennæ is often exactly as in *C. albidus* Jurine. The serrations do *not* "form gradually." I have several times observed a young specimen of *C. fuscus* just before the last ecdysis. In such cases there was a finely serrated hyaline plate on the last segment, but the coarsely serrated plate of the adult form could be distinctly observed below the transparent chitin folded flat down along the segment. In every case the serrations of the coming plate were complete. In her conclusion Miss Byrnes states that "there are wide ranges of variability in the reduced seta on the inner ramus of the fourth foot of *annulicornis* and in the hyaline plate of the antennæ of both varieties—in short, in the most important differential characters of the two varieties." It is not at all surprising that Miss Byrnes considers the "two varieties" so closely related when we find that half of (to her) the "most important differential characters" are concerned with a *single seta* on the inner ramus of the fourth foot. In her description of this species, as well as all the others described by her, Miss Byrnes obviously neither considers the *receptaculum seminis* a most important feature, nor does she mention the presence of sense-club or hair in a single species.

Miss Byrnes has added very little to the evidence of the close relation that may exist between these two species. She gives but one-quarter of the observations in Herrick's "diagnosis," which is incomplete even in its full form, and then draws her conclusion mainly from her own notes on the difference in the single seta of the inner ramus of the fourth foot, already mentioned. I quote from her paper once more. "He (Herrick) states that the two varieties have similar armature of the swimming feet, but that *tenuicornis* differs from *coronatus* in the absence of serrations on the antennal lamellæ and in the divarication of the ovisacs." Here follows the original description of Herrick's "*Cyclops signatus* var. *tenuicornis*. First segment of thorax shorter, its length to that of the entire thorax as 1 : 1.9. Last segment of antennæ with unserrated lamella. Caudal stylets longer, length to width as 2.1 : 1, inner aspect not ciliated. Outer apical seta half as long as inner. Second segment of antennules longer. Color variable, but always banded or splotched. It is also generally true that the ovisacs in the present variety are more strongly divaricate than in the variety *coronatus*." Miss Byrnes now concludes that since "the antennal lamella of *annulicornis* sometimes bears serrations and *coronatus* sometimes bears its egg masses in a divaricate position, as I have found in attempting to distinguish the two forms by this character, ... consequently Herrick's diagnosis is untenable." This gives Herrick absolutely no credit for *six* of his *eight* points of difference noted. Herrick's diagnosis should not be considered untenable, but merely incomplete.

This species, while not as common as *Cyclops albidus,* appears to be quite generally distributed over the United States. Forbes reports it from the "ponds and lakes of Wisconsin, Michigan, Illinois, and Massachusetts," where it "occurs sparingly." Brewer found it with *C. albidus* Jurine (= *C. signatus* var. *tenuicornis* Herrick) in the vicinity of Lincoln, Nebraska, but "always in small numbers." Miss Byrnes has studied the species at Cold Spring Harbor, Long Island. Kofoid does not mention it in his studies of the "Plankton of the Illinois River." I have found it in this locality; rather more abundantly in September, October, and April than during the winter months. I have never found it in very great numbers. During the summer and fall of 1909, it occurred sparingly in collections from Lake Winnepesaukee, N. H., and in a small pond adjoining "Fresh Pond" at Cambridge, Mass.

Specific Description.—The cephalothorax (Pl. I, fig. 1) in this species is a little more than twice as long as the abdomen. They are to each other as 21 : 10. The first segment is to the entire cephalothorax as 7 : 11. The length of the thorax to its width is as 11: 6. In the living animal none of the lateral angles of the thoracic segments are prominent. The posterior borders of the thoracic segments are all unserrated. The fifth segment has a row of minute chitinous teeth extending transversely across the ventral side between the fifth feet. This same segment has on its lateral sides a row of fine spinules as well as a minute fringe of hairs, as in *C. prasinus.*

The abdomen tapers but little towards its posterior end. The first segment is about as long as the three following ones. The posterior edges of the first three abdominal segments are smooth. Occasionally there are very slight and uneven serrations present (Pl. I, fig. 3). The ventral posterior border of the fourth segment has a prominent fringe of spines which do not extend to the edge of the anal opening, as is the case in *C. albidus.* I find no mention of this characteristic in any descriptions of *C. fuscus* that I have at hand.

The stylets (Pl. I, fig. 3) are short; the branches often slightly out-curved. The length is three times the width. Schmeil states that the inner border is "densely" set with hairs. In the specimens from this locality these hairs are often very irregular, rarely "dense," but always present. The apical setæ are well developed and densely plumose. The outer is to the inner as 4 : 7. The longest is to the next in length as 7 : 5.

The first antennæ of the female (Pl. I, figs. 1 and 9) reach to the anterior border of the first abdominal segment. They are seventeen-jointed and bear a minute sensory hair upon the twelfth segment in place of the sense-club found in *C. albidus* (Pl. I, fig. 9). On their anterior edges at the point of juncture with the following segments, the eighth, ninth, tenth, twelfth, thirteenth, and fourteenth segments are ornamented with a row of prominent, obliquely set spinules. These rows of spinules form almost a quarter circle on the eighth, ninth, and tenth segments. On the twelfth and thirteenth segments they are not so closely set and are fewer in number. It is interesting to note that where Schmeil found six spinules on these segments in European forms, I have found but four or five, and on the fourteenth segment where he records four, I have noted five in every case. I have never seen more than seven of these spinules on the eighth, ninth and tenth segments, and the eighth and tenth usually have but five. Besides these regular rows of spinules, there are smaller transverse and longitudinal rows and irregular groups of very minute spinules (Pl. I, fig. 9) on the ventral side of the first fourteen antennal segments. The longitudinal rows mark the boundary between the smooth portion of the segment and that on which the spinules occur.

The three terminal segments bear transparent hyaline plates.

These plates are smooth on the fifteenth and sixteenth segments, but on the seventeenth (Pl. I, fig. 7) the plate is coarsely serrate from the base of the segment to the insertion point of the middle seta; from thence to the end minutely serrated as in *C. albidus.* This plate projects somewhat beyond the end of the seventeenth segment.

The second antennæ (Pl. I, fig. 5) are unusually long. The third segment is the longest of the four—a distinguishing difference between this and the following form. The swimming feet are armed as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, three spines, two setæ.

Marsh has noted that "the larger of the two terminal spines of the endopodite of the fourth foot, instead of being serrated on its edges as is customary in all the spines of the swimming feet, is beset on its inner margin with long, rather irregular teeth." I find this character present in the local specimens, though the "irregular teeth" do not extend to the tip of the spine on its inner margin. There are but five or six of these long serrations at the middle of the inner margin, thence to the tip of the spine the serrations are normal. Schmeil notes that the lamella which connects the basal segments of the fourth pair of swimming feet is ornamented by a fringe of long hairs. This is found also in *C. albidus,* and is therefore hardly a distinctive character of *C. fuscus.* In all the specimens that I have examined, these "hairs" are very coarse, resembling rather long serrations. There is a very noticeable characteristic in the lamella between the basal joints of the *third* pair of swimming feet. There are two very minute rows of blunt spinules extending transversely across the lamella. The upper row is broken in the middle. In the following species this character is very different.

The fifth foot is practically identical with that of the following species. Miss Byrnes states that the basal segment of the rudimentary fifth foot in "*coronatus*" (= *C. fuscus*) is conspicuously short. Schmeil finds no such difference. Among all the representatives of *C. fuscus* that I have compared with *C. albidus,* I have found only very slight differences in the lengths of the basal segments of the fifth feet. The *apparent* difference in length may often be accounted for by the strongly arched cephalothorax of *C. albidus*, which enables the animal to place the fifth feet close upon the first abdominal segment. In *C. fuscus* the shorter basal segment is frequently only a foreshortening because of the angle at which the feet are held. The arrangement of the spinules, the spines and the setæ are exactly as in *C. albidus* (Pl. I, fig. 13).

The *receptaculum seminis* (Pl. I, fig. 11) consists of two main divisions. The anterior portion is wide, shaped very much like the corresponding portion of the receptaculum in *C. albidus*, but with a very distinct indentation on its anterior border. The posterior part appears as a pair of slightly elongated reniform divisions separated by a median line and fusing at the porus. The color of the receptaculum is always a deep reddish-brown which frequently makes it difficult to distinguish its outline.

The egg-sacs are carried very close to the abdomen. The eggs are dark; in the living animal they look quite black, but in reality they are a deep shade of brown. This applies only to freshly deposited eggs, as all *Cyclops* eggs from which the young are about to emerge show a characteristic salmon tinge due to the color of the bodies of the nauplius.

The length of the female varies but little. The following five measurements give an approximate average for *C. fuscus* from this locality. All measurements include the caudal setæ.

No. 1	3.75 mm.
No. 2	3.2 mm.
No. 3	3.4 mm.
No. 4	3.4 mm.
No. 5	3.58 mm.
Average	3.46 mm.

Schmeil gives 3.4 mm. Brewer's figures are much smaller—1.4 mm.–1.8 mm. The males are often only half as long as the females. An average length is 1.75 mm.

The color of the first four thoracic segments and the abdomen from the posterior half of the first segment to the furca is usually a dark green. The fifth thoracic segment, the stylets, and the fourth, fifth, twelfth, thirteenth, and fourteenth segments of the first antennæ are blue. The anterior half of the first abdominal segment is reddish-brown. Occasionally there are irregular blotches and streaks of blue on the posterior borders of the first four thoracic segments. The remaining segments are a dirty yellow color, deeper on the anterior border.

C. fuscus may be readily distinguished from all other members of the genus by its size, dark color, and closely lying dark egg-sacs. The absence of the sense-club of the twelfth antennal segment, the coarsely serrated hyaline plate of the seventeenth antennal segment, the form of the *receptaculum seminis*, and the ciliated inner border of the stylets are the most easily distinguishable characteristics of this species. In order to simplify the comparison of *C. fuscus* with *C. albidus*, I have arranged the following tabulated form for the characters of the two species:

	Cyclops fuscus.	*Cyclops albidus.*
(1) Inner borders of the stylets	ciliated.	smooth.
(2) Third segment of second antennæ	long.	short, pear-shaped.
(3) *Receptaculum seminis*	(Pl. I, fig. 3.)	(Pl. I, fig. 4.)
(4) Twelfth segment of first antennæ bears	sense-hair.	sense-club.
(5) Hyaline plate of seventeenth antennæ segment	coarsely serrate.	finely serrate.
(6) Egg-sacs carried	close to abdomen.	widely divergent.
(7) Length of outer furcal seta to that of inner	4 : 7.	1 : 3.
(8) Furcal setæ	densely plumose.	lightly plumose.
(9) Posterior border of fourth thoracic segment	smooth.	finely serrate laterally.
(10) Serration of posterior border of fourth abdominal segment	do not extend to anal opening.	extend to the anus.
(11) Lamella of third pair of swimming feet	minute spinules.	coarse spinules.
(12) Color	dark (green and blue).	light with occasional black portions.

Schmeil notes differences in the form of the spermatozoa and their position in the spermatophore. The twelve points of difference noted above should enable anyone to distinguish the two forms positively.

Subgenus MARCOCYCLOPS Claus.

Cyolops albidus Jurine. Pl. I.

Monoculus quadricornis var. *albidus* Jurine, '20, p. 44, pl. II, figs. 10 and 11.
Cyclops signatus var. *tenuicornis* Herrick .and Turner, '95, pp. 106, 106, pl. XV, figs. 5–7; pl. XX, figs. 1–7; pl. XXXIII, figs. 1, 2.
Cyclops albidus Schmeil, '92, pp. 128–132, pl. I, figs. 8–14*b*; pl. IV, fig. 15.
Cyclops albidus Forbes, '97, pp. 47–49, pl. XIII.
Cyclops albidus Lilljeborg, '01, pp. 49–51, pl. III, figs. 21 and 22.
Cyclops albidus v. Daday, '06, p. 184.
Cyclops signatus annulicornis Byrnes, '09, pp. 10–13, pl. IV.

Specific Description.—The first segment of the strongly arched elliptical cephalothorax (Pl. I, fig. 2), is in the proportion of 3 : 4 compared with the entire length of the cephalothorax. The lateral angles of the segments are not prominent. The fifth segment is rarely visible from above, owing to the arched form of the cephalothorax. The first three segments are smooth along their posterior borders. I find in all of the specimens examined from this locality that the fourth segment has on its posterior border, laterally and not extending to the median line, a row of very minute chitinous serrations. These are only visible when the animal is turned on its side. I find no mention of these serrations in any of the descriptions of this species to which I have access. The fifth segment bears, dorsally situated, three transverse rows of spinules. The last of these is the only complete one and borders the segment posteriorly. The second row does not extend to the median line. The first row is quite short, lateral in position, and the spinules are considerably larger than in the other two. Schmeil states in his note number three, p. 130, that, with two exceptions, these rows of spinules have "never been observed." In Cragin's paper of '83 in his description of *Cyclops tenuicornis* Claus (= *Cyclops albidus* Jurine), he says: "Either side of the fifth thoracic segment is furnished with three transverse rows of serrulations, of which the posterior one is marginal." Furthermore, he illustrates the point in his Pl. II, fig. 13. His drawing is inconsistent, however, with his description, as it does not show the marginal row extending the entire width of the segment. Forbes, very properly, does not mention the row of blunt spinules between the insertion points of the fifth feet. This is not a "characteristic," as it is found in *Cyclops fuscus* Jurine.

The width of the cephalothorax is to its length as 1 : 2. Its length to that of the abdomen is as 7 : 4. (Schmeil reverses these figures and gives abd. : ceph. : : 9 : 5, obviously an oversight).

The abdomen is heavy; the first segment tapers only slightly, but the enlargement at the anterior end extends beyond the width of the last thoracic segment. The second and third segments are cylindrical and their posterior margins are very slightly and unevenly serrated, largely on the under side. The fourth segment has the usual fringe of spines on its posterior edge, and tapers suddenly to the insertion point of the stylets. The stylets (Pl. I, fig. 4) are short, but slightly divergent and smooth on their inner sides. This is an important character which Forbes does not note in his description. The proportion of the length to the breadth of each ramus is 3 : 1. There are four well-developed apical bristles. The longest is to the second in length as 7 : 5; the outer to the inner as 1 : 3. They are all plumose, but not as densely so as in *Cyclops fuscus* Jurine.

The first antennæ vary very little in length. In the female they usually reach to the middle or posterior border of the last thoracic segment. They are seventeen-jointed, the terminal joints attenuated, the last three being each armed with an hyaline plate. The edges of these plates on the fifteenth and sixteenth segments are for the most part entire, but I have repeatedly seen them, especially at the base of the fifteenth segmental plate, minutely serrated. More rarely these serrations extend along the entire edges of all three plates. The plate of the last segment is always finely serrated on its distal half. The point where these serrations cease and the smooth edge begins is sharply defined by a much deeper notch or indentation (see Pl. I, fig. 8). The twelfth segment bears a well-developed sense-club (Pl. I, fig. 10). Its length is about equal to that of the thirteenth segment. All of the segments, except the three terminal ones, bear an irregularly broken, longitudinal row of minute spinules on their under side. The eighth, ninth, tenth, twelfth and thirteenth segments have each a short row of small cone-shaped serrations at the point of juncture with the following segments, as in *Cyclops fuscus*. The twelfth segment (Pl. I, fig. 10) has, in addition, several (usually two) rows of smaller spinules extending parallel to the marginal semicircular row.

Marsh ('95) failed to find these "crowns of spines" on the antennæ of "a large number of mature females" of *C. albidus* which he "examined with great care." He concludes that this peculiar character "seems to be rarely true in our forms." Forbes has found it in the specimens examined by him from many parts of the country. I have never failed to find it in the local specimens.

The third segment of the second antennæ (Pl. I, fig. 6) is short and somewhat pear-shaped. The armature of the swimming feet is as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, one seta, one spine, four setæ.

Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.

Third pair—like second.

Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines (inner smooth-edged), two setæ (distal one reduced) (see Pl. I, fig. 14).

The lower row of spinules on the lamella connecting the basal segments of the third pair of swimming feet is very large and well developed (about twelve coarse spinules).

The fifth foot (Pl. I, fig. 13) is essentially like that of *C. fuscus* Jurine. Lilljeborg, in his Pl. III, fig. 21, shows the fifth foot differing from that of *C. fuscus* (fig. 13) on the same plate by the absence of the rows of spinules on the two segments. The fifth foot consists of two segments. The basal segment is slightly convex on its outer margin, while the inner margin is correspondingly concave (see Pl. I, fig. 13). Toward the inner lateral surface of this same segment there are several, usually three, rows of well-developed spinules. At the outer distal corner it bears a long seta, plumose on its distal half. The distal segment is set well towards the inner side of the lower segment and at the point of juncture is ornamented with a $\frac{3}{4}$ circle of small spines. It bears on its tip two heavy spines and a slender seta. The inner spine is slightly longer than the outer. At its base there is a semicircle of quite prominent spinules. Both of these spines are more densely plumose on their inner edges. Between them and borne at the end of a truncated cone-shaped projection is the long middle seta. It is only slightly plumose at its distal end, and these hairs (8–10 on each side) are placed at regularly diminishing intervals.

The shape of the *receptaculum seminis* (Pl. I, fig. 12) can be readily noted. The anterior division is almost elliptical when fully distended. The posterior portion is two-lobed and has the form of a low, widely spread letter w. This organ is practically colorless, and for this reason its form can be unmistakably observed.

The egg-sacs (Pl. I, fig. 2), carried at a considerable angle from the abdomen, are nearly as long as the abdomen. In a ♀ in which the abdomen measured .6 mm. the egg-sacs were .57 mm. long.

In discussing the size of this species, Forbes states that "the usual length of the female in America is from 1.26–1.4 mm., but it seems to be much greater (2.5 mm.) in the European representatives of this species." It is interesting to note the measurement of the following five females taken at random:

No. 1	2.5 mm.
No. 2	2.51 mm.
No. 3	2.21 mm.
No. 4	2.50 mm.
No. 5	2.47 mm.

This gives an average measurement of 2.43 mm. for representatives of the species from this locality—less than .1 mm. difference in size from European forms. Taking Forbes' figures and the above together, we get an average measurement of 1.88 mm.

The color, a blue-gray, occasionally nearly black, is most prominent in the stylets and last abdominal segment, the second, third, first half of the fourth, ninth and tenth segments of the first antennæ (♀) and in irregular transverse bands, usually four, on the cephalothorax. The remaining portions of the animal are nearly colorless or a pale shade of yellow, though I have frequently noted individuals in which they were a bright blue-green.

The species seems to be one of the commonest not only in America, but all over the world. Forbes found it "in all localities examined." In nearly all the lists of crustaceans to which I have access it is recorded as a common but rarely abundant variety.

Kofoid records it as "numerically the least important of the dominant members of the genus in our plankton" (Illinois River). I have found it to be one of the commonest of the *Cyclopidæ.*

Miss Walker has studied the species in Todd's Pond, Oregon, where she found it to be, with *Cyclops serrulatus,* second in abundance after *Cyclops prasinus.*

In collections made during the summer of 1909, at Lake Winnepesaukee and in the vicinity of Cambridge, Mass., in March and April, 1910, *C. albidus* was a common but not an abundant form.

Subgenus ORTHOCYCLOPS Forbes.

Cyclops modestus Herrick. Pl. II, figs. 6-11.

Cyclops modestus Herrick, '83*a*, p. 500.
Cyclops modestus Herrick and Turner, '95, pp. 108, 109, pl. XXI, figs. 1–5.
Cyclops modestus Marsh, '93, pp. 213, 214, pl. V, figs. 10–13.
Cyclops capilliferus Forbes, '93, pp. 248, 249, pl. XL, figs. 14–17; pl. XLI, fig. 18.
Cyclops modestus Forbes, '97, pp. 51–53, pl. XV, fig. 4; pl. XVI, figs. 1–3.
Cyclops modestus Byrnes, '09, pp. 26, 27, pl. XI, figs. 4 and 5.

Specific Description.—The shape of the cephalothorax is very characteristic in this species (Pl. II, fig. 6). The first segment reaches its maximum width considerably in front of the posterior border, and the anterior border line is somewhat straighter than usual, resembling *C. prasinus* in this respect. This segment is to the entire thorax as 5 : 8. The fourth segment is regularly, semicircularly excavate on its posterior margin. Forbes finds the posterior edges of the first three segments irregularly notched, but the fourth smooth. I am unable to verify this observation; all the thoracic segments of specimens examined by me had smooth posterior edges. The thorax is about twice as long as wide and one-third as long again as the abdomen.

In the male the cephalothorax (Pl. II, fig. 7) tapers only a very little. The first segment is distinctly concave on its anterior border. It expands abruptly in its anterior third, but its middle does not attain the width of the preceding thoracic segment. The first three segments have smooth or faintly uneven posterior margins. The last segment Forbes notes to be "peculiar in lacking the usual fringe of spines on the posterior edge." I have noted on either side of the anal opening peculiar, out-curving, hook-like projections of the chitin (Pl. II, fig. 8) on the posterior border of the fourth abdominal segment. Otherwise its edge is smooth. It is interesting to note that half-way between the anterior border of the anal opening and the posterior margin of the third abdominal segment there are present in this, as in all the *Cyclopidæ,* two peculiar button-like projections whose function may be sensory (Pl. II, fig. 8).

The stylets (Pl. II, fig. 8) are rather slim and about twice as long as the fourth abdominal segment. Their length is four times their width. The lateral spine is inserted slightly beyond the middle of each ramus and from this point half-way to the posterior margin of the stylets, they are in the female peculiarly excavate. Along the curving line that marks this character there is a very minute row of spinules. The outer apical seta is rather short and finely plumose. The other three apical setæ are all well developed. The outer is to the inner as 4 : 3. The middle is the longest and is to the next in length as 3 : 2. Though Forbes has shown the inner borders of the stylets to be densely and coarsely plumose in his fig. 4 of Pl. XV, he fails to mention this character in his description. I have never seen a specimen of *C. modestus* with the stylets as densely plumose as he shows them to be. All of the specimens examined from this locality showed very fine and often unevenly distributed hairs on the inner surfaces of the stylets (Pl. II, fig. 8). They are only visible under a high power.

The female first antennæ consist of sixteen segments. Herrick notes a similar form with seventeen joints, but this again I am unable to verify. They extend a little beyond the posterior margin of the first thoracic segment. The second, third, tenth, and thirteenth segments bear unusually long, heavy, plumose setæ. In the males these spines, which correspond to those of the third segment in the female antennæ, are very conspicuous (Pl II, fig. 7). When the first antennæ are folded under the body they protrude as shown in the figure. This also occurs when the female antennæ are folded under the cephalothorax. The female antennæ show an unusual change of direction between the third and fourth segments, giving the animal a characteristic appearance and making the females resemble the males to the naked eye. On the fourteenth and fifteenth segments of the first female antennæ occur several characters that may be sensory in function. The fourteenth segment bears a minute sensory hair and a very inconspicuous, transparent, hyaline plate that contains about twelve coarse serrations (Pl. II, fig. 11). The fifteenth segment bears a smooth-edged hyaline plate of which the distal end is club-shaped and protrudes considerably beyond the anterior end of the segment. Forbes ('97) indicated the position of this plate in his fig. 1, Pl. XVI, of the first female antennæ, but he seems to have overlooked the character of the organ. In the figure, the positions of the large setæ of the fourteenth and fifteenth segments are indicated.

The armature of the three segmented swimming feet is very constant. The setæ and the apical spines are long and slender. Forbes notes that "the distal segments of the third and fourth pairs of legs turn inward in a way peculiar to this species." The inner border of the distal segment of the inner ramus of all four pairs is finely plumose. The feet armature is as follows:

First pair—outer ramus, four spines, four setæ; inner ramus, six setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, six setæ.
Third pair—outer ramus, three spines, five setæ; inner ramus, six setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The lamellæ connecting the swimming feet have a peculiar form. Pl. II, fig. 10, shows this feature in the third pair. In the fourth pair the place of the seta on the basal joint is taken by a short chitinous point. The lamella of the second pair is similar to that of the third, while in the first pair the chitin points have become quite rounded and smooth.

The fifth foot (Pl. II, fig. 9) is generally considered as having three joints. Forbes states that it "has three freely movable segments, though the basal one is small." Miss Byrnes simply states that "the fifth foot is *very distinctly* three-jointed, and not 'obscurely' as Herrick observed." The basal segment is certainly very short, though its presence is no longer a matter of conjecture. Whether it is "freely movable" I am unable to say. The second segment is almost square and bears a short seta on its outer side. They are both plumose and the larger is borne at the end of a slight projection of the segment. The shorter of these setæ is usually folded under the longer, as shown in the figure. The rudimentary feet in this species are unusually large.

The *receptaculum seminis* is very much like that of *C. bicuspidatus* Claus. The anterior division is very low, extending but a little beyond the porus. The posterior, bag-shaped portion reaches halfway to the posterior margin of the abdominal segment.

The egg-sacs are narrow and extend a little beyond the ends of the stylets. They usually contain from 10–12 dark ovæ.

Forbes gives 1.2 mm. for the length of *C. modestus*. I find it slightly larger, 1.3 mm. being an average length for females.

The color of this species is most beautiful, violet and lavender shades predominating. It is evenly distributed in the chitin and persists in preserved material. There are usually a number of large, orange-colored globules below the chitin. These are specially numerous in the cephalothorax and the swimming feet.

C. modestus can be readily distinguished from all other species by the sixteen-jointed first antennæ, the three-jointed fifth foot, the very characteristic stylets, and the *receptaculum seminis*.

While nowhere an abundant species, *C. modestus* appears to be very generally distributed over the United States. Forbes reports it from several localities in Illinois and from Grebe Lake in the Yellowstone Park. Marsh found it in Rush Lake, Wisconsin, and Herrick in Cullman County, Alabama. Miss Byrnes has recently studied the species from the Long Island waters. I have found it, always in small numbers, one of the rarer species of the genus from this locality.

In a collection from "Fresh Pond," Cambridge, Mass., made in the fall of 1909, this form outnumbered all other species. It occurs also in collections from Lake Winnepesaukee made during July and August, 1909.

Subgenus MICROCYCLOPS Claus.

Cyclops varicans Sars. Pl. III, figs. 6-10.

Cyclops varicans Sars, '62, pp. 252, 253.
Cyclops varicans Schmeil, '91, pp. 33, 34; '92, pp. 116-118, pl. VI, figs. 1-5.
Cyclops varicans Forbes, '97, pp. 63 and 64.
Cyclops varicans Lilljeborg, '01, pl. IV, figs. 23, 24, pp. 72-74.
Cyclops rubellus Lilljeborg, '01, pl. IV, figs. 25 and 26, pp. 75-77.
Cyclops bicolor Byrnes, '09, pl. XIII, pp. 29-31.

Synonymy and Distribution.—Though I am unable to translate Lilljeborg's Swedish description of his new species *C. rubellus,* I am convinced from the Latin synopsis as well as his drawings of the *receptaculum seminis* and abdomen that this species is synonymous with *C. varicans* Sars. His drawing of the *receptaculum seminis* shows this organ to have the form of that pictured by Schmeil (Taf. VI, fig. 3) with a slightly greater expansion of the "wings" of the anterior division. By a careful study of this organ in a number of specimens, I have concluded that what Lilljeborg pictures as the *receptaculum seminis* of the type *C. varicans* (see Taf. IV, fig. 24, of his paper of '01) is the extreme form of narrow anterior portion, Schmeil's drawing showing a slightly greater expansion of this same division. Lilljeborg's drawing of the *receptaculum* of *C. rubellus* and my own (Pl. III, fig. 10) of this organ in *C. varicans* are examples of the extremely wide and wing-like form. The proportional lengths of the caudal setæ, as shown by Lilljeborg, are identical with those of the typical *varicans* (Pl. III, figs. 6 and 7).

Miss Byrnes in her recent paper (March, '09) has described a species of *Cyclops* under the name of *C. bicolor.* Her description of the antennæ, which she states "contain each twelve segments," at once suggests *C. varicans,* for nowhere do I find a record of *C. bicolor* with more than eleven joints in the first female antennæ. Schmeil gives eleven, Lilljeborg 10-11, and Marsh has noted a form with ten segmented antennæ, though he finds the usual number is eleven. Herrick, with whose description she seems to have compared her own, also gives eleven as the number of female antennal segments. Miss Byrnes' formula for the swimming feet agrees exactly with that of specimens examined from this locality. In speaking of the variation of this species, she says: "The species *C. bicolor* is usually placed (*e.g.,* by Marsh) among Cyclops having ten or eleven segments. The occurrence, therefore, of a twelve-jointed antenna shows that considerable variation may occur in this organ. Except in this respect, the form from Cold Spring Harbor agrees with Professor Marsh's description." The above extract needs no comment. Herrick assigns *C. varicans* a place among the twelve-jointed-antennæ forms having a *two*-segmented fifth foot. This may account for Miss Byrnes' error, for Herrick's drawing of the fifth foot of *C. varicans* is quite incorrect.

C. varicans is one of the rarer species of the genus. Schmeil found it sparingly in the vicinity of Halle. Lilljeborg reports it and describes it from Sweden. Herrick found it but once, and Miss Byrnes also collected it in a single instance from a pond on Long Island, describing it as a twelve-jointed variation of *C. bicolor*. In his summary of species Forbes records it as "a fairly common species throughout the range of *Cyclops* in North America." I have found it in small numbers in the March and April, 1909, collections in this locality and sparingly in the vicinity of Cambridge, Mass., and from Lake Winnepesaukee collections taken in July and August, 1909.

Specific Description.—The first segment of the almost elliptical cephalothorax (Pl. III, fig. 6) is about as long as wide and a little over half as long as the entire thorax (3 : 5). The lateral angles of the third, fourth, and especially the fifth thoracic segments are prominent. The proportion of cephalothorax and abdomen is as 10 : 7. The posterior borders of all the thoracic segments are smooth. The fifth segment is somewhat flattened and extended laterally. Its lateral edges protrude considerably beyond the first abdominal segment. At the ends of these wing-like projections of the fifth thoracic segment are inserted long, curving, plumose setæ, which are usually considered homologous to the outer setæ of the basal segments of the two-jointed rudimentary fifth feet. The fifth feet are inserted at the inner corners of the lateral projections of the fifth thoracic segment on its posterior edge (Pl. III, fig. 9).

The first abdominal segment is considerably expanded in its anterior half (Pl. III, figs. 6 and 10). The entire abdomen, which is rather slim, tapers gradually to the furca. The posterior borders of the first three segments are smooth. On the posterior edge of the fourth abdominal segment, ventrally placed and rarely extending half way around the circumference of the segment, there is present a short row of long serrations.

The stylets (Pl. III, fig. 7) taper slightly and are carried very close together. They are slightly shorter than the last two abdominal segments taken together. The outer apical bristle is rather heavy, sparsely plumose, and nearly as long as the delicate inner one. Of the two developed apical setæ, the inner longer one is to the outer as 10 : 7. Schmeil shows both of these setæ to be evenly plumose on their distal seven-eighths. This character is rarely present in the specimens from this vicinity. The anterior plumose portion is replaced by a short row of delicate spines on either side of the setæ (Pl. III, fig. 7). These do not merge into the hair-like forms gradually, but end abruptly at the beginning of the plumes as in the long median caudal seta of *C. phaleratus*. The lateral spine is inserted two-thirds of the length of the stylets from their anterior border. It is usually delicately plumose, although the bare form is not rare.

The female first antennæ may have either eleven or twelve segments. The number given by Schmeil is twelve, but I have frequently found eleven-jointed sexually mature forms, bearing eggs. Such forms occur more frequently in late winter and the twelve-jointed-antennæ forms in April and May (Pl. III, figs. 6 and 8). The antennæ are a little over two-thirds as long as the first thoracic segment. The division from eleven to twelve joints takes place in the third joint. The fourth, fifth and sixth joints are often narrower than the seventh and eighth. Most of the antennal bristles are not plumose. Schmeil notes the presence of a well-developed, closely lying sense-club on the ninth segment. This I cannot discover on the specimens that have come under my observation. In its place there is a minute sensory (?) hair.

The first antennæ of the male are peculiar in the unusual development of the sensory structures of the first division. These are larger than in any other species of the genus and may be readily noted even under a slight magnification as long blue, semi-transparent, narrow bag-shaped structures on the posterior side of the antennæ.

The swimming feet are all two-jointed. The outer ramus of the fourth pair is generally visible from above in life. This is due to the unusually large lamella connecting these feet which makes them protrude at a greater lateral angle. Schmeil notes that the fourth pair of swimming feet is less fully developed than the other three pairs. In fig. 11 of Pl. III I have shown a foot of the third pair. It is interesting to note an indication of the third segment; a row of short hairs at the middle of the distal segment of the outer ramus and a group of longer hairs on the corresponding segment of the inner ramus. This character is always present in the first three pairs of swimming feet.

The armature of the swimming feet is as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.

Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, five setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, five setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, three setæ.

The above armature is quite constant. Herrick states the fifth foot is two-jointed. Since he has only collected the species in a single instance, this must be considered an error. There is often a very inconspicuous indication of a former large basal segment (Pl. III, fig. 9), but the movable fifth foot consists of a single cylindrical joint. At the middle of its distal end there is borne a long, delicately plumose seta (Pl. III, fig. 9).

The shape of the *receptaculum seminis* has already been discussed. Fig. 5 of Pl. III shows what is probably the extreme "wing-like" formation of the anterior division. The posterior portion is about as long as the anterior and has the form of a short bag. The porus is situated immediately between the two portions on the narrow transverse division that extends entirely across the first abdominal segment.

The egg-sacs contain from ten to twelve ovæ and are carried at a slight angle from the abdomen.

The following measurements of six females taken at different times give an average length of .867 mm.

No. 1..........Total length = .895 mm.
No. 2.......... " " = .841 mm.
No. 3.......... " " = .966 mm.
No. 4.......... " " = .96 mm.
No. 5.......... " " = .89 mm.
No. 6.......... " " = .89 mm.

The females average .21 mm. in width. The males are somewhat smaller than the females—.69 mm. being an average length. Schmeil gives .8–.92 mm. for the size of the females and "about" .7 mm. for the males. Sars' figures are somewhat greater—1 mm. Herrick gives .8 mm.

The color of *C. varicans* is ordinarily very pale. A faint shade of yellow is noticeable throughout the body, making the animal unusually inconspicuous. It may be readily distinguished from all other species of the genus by its short, twelve-jointed antennæ, the very characteristic *receptaculum seminis*, and the two-jointed swimming feet.

Subgenus EUCYCLOPS Claus.

Cyclops prasinus Fischer. Pl. III, figs. 1–5.

Cyclops prasinus Fischer, '60, pp. 652–654, pl. XX, figs. 19–26*a*.
Cyclops fluviatilis Herrick, '82, p. 231, pl. VII, figs. 1–9.
Cyclops magnoctavus Cragin, '83, pp. 70, 71, pl. III, figs. 14–23.
Cyclops prasinus Schmeil, '92, pp. 150–156, pl. V, figs. 1–5.
Cyclops fluviatilis Herrick and Turner, '95, pp. 114, 115, pl. XXVI, figs. 1–8; pl. XXX, fig. 1.
Cyclops prasinus Forbes, '97, pp. 57–59, pl. XIX, figs. 1 and 2; pl. XX, figs. 1 and 2.
Cyclops fluviatilis Brewer, '98, pp. 135, 136.
Cyclops prasinus v. Daday, '06, p. 180.
Cyclops fluviatilis Byrnes, '09, pp. 28, 29, pl. XV, figs. 1 and 2.

Specific Description.—The form of the cephalothorax in this, the smallest species found in this locality, is that of an ellipse slightly flattened at the ends. The first segment is to the total length of the cephalothorax as 5 : 7. Its length is to its width as 5 : 4. The lateral angles of all the thoracic segments are obscure. Their posterior borders are unserrated. The lateral edges of the last segment bear each a fringe of very minute hairs (Pl. III, fig. 5).

The abdomen, which is to the cephalothorax as 5 : 9, is rather slender and tapers only slightly towards its posterior end. The first segment is enlarged at its anterior end and about as wide as the last cephalothoracic segment. The posterior borders of all the abdominal segments are unevenly and minutely serrated.

The short stylets (Pl. III, figs. 1 and 2) stand well apart in the living animal. The lateral spines are situated $\frac{3}{5}$ of the length of the stylets from their anterior end. Of the apical setæ only two are well developed. The inner and outer bristles are small. Of these the outer is much heavier and is slightly shorter than the inner. Neither attains the length of the stylets. Of the large middle pair the inner is to the outer as 5 : 3. Brewer gives 4 : 5 "or equal." The larger of the two is four times, the shorter about three times, as long as the stylets. Both are delicately plumose.

The first pair of (twelve-jointed) antennæ (Pl. III, fig. 1) reach in the female to the posterior border of the third thoracic segment. Forbes finds them often reaching "quite to the first abdominal segment." The eighth joint is the longest, exceeding that of the two preceding segments. Dr. Schmeil finds on the ninth segment a "well-developed sense-club," and, in his foot-note, states that Richard "even denied the presence of a sense-club." All of my specimens agree with Forbes' description in the absence of the sense-club, but "minute sensory bristle" on the tenth segment. This seems, then, to be undoubtedly a characteristic point of difference from the European forms. The three terminal joints are slightly curved and each bears a well-developed hyaline plate. The edges of these plates, which Forbes found to be entire, seem to vary. I have frequently found them finely serrated on the distal *third* of the terminal segmental plate. Again I have noted a very distinct notch or indentation at the posterior end of the serrations. This resembles somewhat the characteristic "notch" in the corresponding plate of *Cyclops leuckarti* Claus, though it is not so deep nor conspicuous. Occasionally I have observed a specimen in which all *three* hyaline plates were finely serrated. The commonest form has two of the plates with smooth edges, though the plate of the last segment invariably has the slight notch mentioned above (Pl. III, fig. 3).

The very long and strong setæ on the first and fourth antennal segments and the change of direction of the remaining segments beyond the fourth, as well as the short caudal stylets, suggest a superficial resemblance to *Cyclops modestus* Herrick.

The four pairs of swimming feet are armed as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, six setæ.
Third pair—like second.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, three setæ.

Both the spines and setæ of these feet are peculiarly long and slender.

The rudimentary fifth foot (Pl. III, fig. 4) consists of a single segment, armed with a spine and two setæ. The spine is inserted immediately above the characteristic bulge of the minutely plumose inner side. The longer of the two setæ is borne at the end of a cone-shaped projection of the distal end of the segment. The remaining seta is inserted on the outer side of the segment at the base of the cone-like process. Its length is two-thirds that of the apical seta and slightly greater than that of the spine. Both the setæ are delicately plumose; the spine is more coarsely so. Brewer notes that the "three setæ" are bare in his specimens.

The form of the *receptaculum seminis* (Pl. III, fig. 5) is the most characteristic feature of this species, though it is frequently quite difficult to distinguish owing to the density of the pigment matter in the first abdominal segment. It consists of two very distinct divisions. The anterior portion has a central arm extending halfway to the upper edge of the first abdominal segment, which branches into two wing-like projections at right angles to the central arm and extending transversely across the abdomen on either side of the median line. The outer ends of these projections are often slightly enlarged. Forbes and Schmeil both find that these side arms are "S-shaped." Among all the specimens that I have examined from this locality, I have noted the "S shape" in only one instance. In many cases the outer ends of the wing-forms tend to turn up slightly, but the "S-shaped" canals are certainly the exception and not the rule among the local representatives of this species. Consequently, in my drawing (Pl. III, fig. 5) I have shown what I consider a rather more characteristic form of the *receptaculum seminis* for *C. prasinus.* This somewhat insignificant detail shows that the *receptaculum seminis* may be a variable character.

The portion of the receptaculum behind the suture consists of two lateral sacs connected by a narrow transverse canal lying close under the suture. In the middle of the anterior edge of this lower connecting arm is the porus. The anterior division of the receptaculum fuses with the posterior at this same point.

The contents of the upper and lower portions differ in appearance only. Dr. Schmeil has proved that the spermatozoa in the upper portion are simply more densely packed together than in the lower.

The egg-sacs contain only a few ova. I have never noted more than ten; seven is an average number. They adhere closely to the abdomen, often covering two-thirds of its dorsal area.

An average length for the female from this locality is .82 mm. Forbes gives .48–.7 mm. Some of the European measurements are as follows:

Vosseler	1.0 mm.
Richard	.9 mm. (after Schmeil).
Vernet	.88 mm.
Schmeil	.8–.9 mm.

The males average .62 mm. long and .14 wide. They have a very long setæ at the distal end of the first division of the first antennæ.

The color seems to be quite constant. The first thoracic segment is a pale yellowish-brown with irregular patches of blue-green along its posterior border. The remaining thoracic segments are a deep shade of blue-green. The first abdominal segment is brown, more dense in the anterior half. The remaining segments are irregularly blotched with the thoracic shade of green which becomes solid in the stylets. The first pair of antennæ are a brownish-yellow; their anterior border is often tinged with green. Forbes has "seen both blue and pink individuals." Herrick found that the color varies "from deep indigo to greenish-brown." Cragin states: "Animal dirty blue-green, antennæ lighter. Dark green pigment masses are scattered beneath the integument in various places, particularly along the anterior side of the first antennæ."

This species is quite generally distributed over the eastern and central United States. Herrick found it in Lake Minnetonka, Minn. Marsh reports the species from Lake Erie, Lake Michigan, and some of the smaller lakes of Michigan and Wisconsin. Forbes has found it in collections from Sister Lake, Fla., and many localities in the State of Illinois. As *C. fluviatilis* Herrick, Brewer reports it from the vicinity of Lincoln, Nebraska, and Miss Byrnes from Long Island. Miss E. R. Walker reports it as the most abundant form from Todd's Pond, Oregon. It is one of the most abundant forms in September and October dredgings, but I have noted only a few individuals during the winter months.

It is easily distinguished by its small size, its habit of swimming near the surface, its dark color (it frequently appears to be black to the naked eye), and, under the microscope, by the very characteristic form of the *receptaculum seminis* and short caudal setæ.

Subgenus PARACYCLOPS Claus.

Cyclops phaleratus Koch. Pl. IV, figs. 1-4.

Cyclops phaleratus Koch, '35–'41, Heft 21, pp. 8, 9, pl. IX.
Cyclops perarmatus Cragin, '83, pp. 72, 73, pl. I, figs. 9–18.
Cyclops phaleratus Schmeil, '92, pp. 170–178, pl. VIII, figs. 1–11.
Cyclops phaleratus Herrick and Turner, '95, pp. 120, 121, pl. XVII, figs. 1–7; pl. XVIII, figs. 2–2*d;* pl. XIX, fig. 1; pl. XXI, figs. 6–10.
Cyclops phaleratus Marsh, '95, pp. 19, 20.
Cyclops phaleratus Forbes, '97, pp. 59–62, pl. XX, fig. 3.
Cyclops phaleratus Lilljeborg, '01, pp. 105–109, pl. VI, figs. 20, 21.
Cyclops phaleratus Byrnes, '09, pp. 31–33, pl. XIV, figs. 1–9.

Specific Description.—The first segment of the unusually broad cephalothorax is a little longer than the other four thoracic segments. Its width is slightly greater than its length. The posterior borders of the first three thoracic segments are smooth. The fourth segment is ornamented with a minute fringe of short serrations. The chitinous covering of the fifth thoracic segment is composed of a continuous cylinder like the abdominal segments, and not of a dorsal and ventral plate, as is the case in the corresponding segment of other species of this genus. This segment is armed ventrally along its posterior margin by a row of heavy, cone-shaped teeth (Pl. IV, fig. 4) which extend at a slight angle and not parallel to the body. This row is, furthermore, not continuous, but generally interrupted in the middle for a short distance on either side of the median line. Occasionally, however, I have noted specimens in which this row of spinules is practically continuous, though there is always a slight break. The length of the entire cephalothorax to that of the abdomen is as 7 : 5.

The first abdominal segment is very slightly smaller than the fifth thoracic segment, and the whole abdomen tapers but little. How small this taper is may be readily seen from the following proportional width of each segment at its posterior border.

First segment	27
Second segment	26
Third segment	24
Fourth segment	21

The proportional lengths of the four abdominal segments beginning with first are 11 : 7 : 6 : 2. All the segments are cylindrical. The posterior borders of the first, second, and third segments are minutely serrated (Pl. IV, fig. 2). The last abdominal segment is less than one-fifth as long as the first segment and bears on its posterior border a fringe of unusually long and heavy spines (Pl. IV, fig. 2).

The stylets are short (Pl. IV, fig. 2). Their length and width are to each other as 4 : 3—a proportion that shows them to be very wide. Below the point of insertion of the short lateral spine, which may or may not be plumose, the stylets taper rapidly. In addition to this lateral spine, there is a row of slightly shorter spinules (usually from four to six) extending from the lateral spine, ventrally, slightly below the middle of the side of each stylet. Forbes mentions "a row of long spinules on the ventral side of each ramus, extending from the middle line of the anterior border to the point of insertion of the lateral spine." I have never noted such a row of spinules in any of my specimens, though this entire minutely spinose armament of the stylets must be considered a variable feature. There are two or three rows of minute hairs extending obliquely from the middle of the anterior border of each stylet towards the posterior border. The interior border of the stylets is often plumose (Schmeil found an "unbehaarten Innenrande") and the inner and posterior dorsal surfaces are armed with irregular groups and rows of short, blunt spines (Pl. IV, fig. 2). Forbes and Schmeil both note that the outermost apical bristle "is placed high up on the side of the stylet." In his fig. 1 on pl. VIII, Schmeil has shown this to be the case, but in fig. 2 of the same plate he shows this spine inserted directly beside the shorter of the two developed caudal setæ. I have found it only as he shows in fig. 2 (Pl. IV, fig. 2). This spine is often quite blunt and always densely plumose on both sides. At the point of insertion there are several long, dorsally placed serrations extending a third of the distance about the base of the spine. The innermost bristle is very delicate, about as long as the outer, and plumose on its outer side only. Of the two well-developed median bristles, the inner is from two and one-half to three times as long as the outer. Its first third is bare, the middle portion fringed with small spines, and the last third finely plumose. It is longer than the abdomen and unusually wide at its insertion point. The smaller of the two developed caudal setæ is bare for one-quarter of its length, thence to its tip it is fringed with a row of small spines on the outside and delicately plumose on the inner. Between the insertion point and the beginning of the outside row of spines there is often a minute fringe of hairs. The dorsal median seta is quite slender, a little longer than the outer apical spine, and not plumose.

The first antennæ of the female (Pl. IV, fig. 3) are eleven-jointed in most cases, though the ten-jointed form appears occasionally. Schmeil records only the ten-jointed form from Germany, and Lilljeborg the same from Sweden in his paper of 1901. Forbes states that they "may be either ten- or eleven-segmented," and Miss Byrnes has noted a single individual in which the left antenna had eleven, the right but ten segments. I have noted a similar individual in a single case. Herrick found that "the antenna is usually ten-jointed, but frequently is eleven-jointed (?), and is much shorter than the first thoracic segment." The question-mark seems to indicate some doubt as to the existence of the eleven-jointed form, though subsequent workers have verified his observation in the case of the American representatives of this species. It is interesting to note here that the eleven-jointed form has, as far as I am able to ascertain, been recorded only by the American investigators. In the eleven-jointed form there is borne at the distal end of the eighth segment, in place of a sense-club, a minute sensory bristle. The antennæ taper but little in the first nine joints, the last two being considerably narrower than the others. The last joint bears an unusually strongly developed seta. The armature of the other antennal joints is quite uniform. The length of the female first antennæ is a little more than half that of the first cephalothoracic segment.

Schmeil states the first antennæ of the male are normal. I have noted that there is on the last division an unusually large spine, set well towards the distal end. There is also a small blunt spine with a large comb-like fringe on its outer margin, placed about in the middle of the second large division of the male antennæ. The remaining spines are rather smaller than in other species. On the joints of the first division there are present, on the under side, the usual long, blunt, finely plumose sensory structures.

The second antennæ are very short and broad. The long curving seta of the basal segment I have never found to be evenly plumose as Schmeil shows it. It is usually armed with a row of short spinules on each side of its distal three quarters, while the first quarter bears, only on its upper side, an uneven row of longer spinules. The second segment bears on its outer side a double row of delicate spines, and on its upper side a fringe of spinules and near its distal end a peculiar spine. The distal half of this spine is curved and bears on its upper side a comb-like fringe of fine spinules. The smaller spine on the distal end of the third segment has this same peculiar curve and fringe. The curved setæ at the top of the fourth segment are short and very broad.

The four pairs of swimming feet are all three-segmented, both spines and setæ are well developed, and the outer edges of the first and second segments of each ramus bear rows of heavy spinules. The armature is most variable. For example, I have found on the outer ramus of the first pair either three or four spines and five setæ. Again in the second pair on the corresponding ramus I have found four spines with either four or five *setæ*. In another case I have found on the outer ramus of the fourth foot of the right side, three spines and five setæ and on the same ramus of the opposite side four spines and four setæ. Furthermore, the armature of the inner ramus of the second and third pairs of swimming feet differs consistently from that given by Forbes, in the presence of an extra seta on the inner side. This seta is very obscure and may be overlooked on account of the long spinules on the same side of the ramus, but its existence can be positively identified by its position and by the fact that, though it is often not much larger than the accompanying spinules, it is the only one that is plumose. I give this rather lengthy discussion of the swimming feet merely as an example of the armature *not* being constant nor reliable as a point of differentiation of species. (See Introduction.) The following is an average armature for the local specimens:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.

Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The fifth feet (Pl. IV, fig. 4) are merely flange-like projections of the fifth thoracic segment. They are more lateral than ventral, and there is ordinarily no line marking the position of a former segment. Occasionally, however, I have noted a faint indication of a possible segment, extending from the base of the outer spine obliquely to a point below the inner spine where the large row of serrations connecting the two fifth feet ceases (see description of cephalothorax and fig. 4, Pl. IV). The fifth foot is armed with three nearly equal spines, of which the inner is coarsely plumose, the middle one more finely plumose, and the outer bare or finely and sparingly plumose on its outer side. Schmeil's criticism of Brady's "otherwise excellent drawing," in which he shows all three spines to be plumose, is hardly justifiable (see note 2, p. 176, of Schmeil's monograph). In addition to the three large spines there are several small serrations about the base of the inner spine and an uneven mass of similar small serrations laterally below the outer spine.

The *receptaculum seminis* consists of two nearly equal divisions extending as narrow bands transversely across the entire first abdominal segment. The porus is situated in the middle of the short, median, common portion. Owing to the dark color of this species, the structure of the receptaculum is extremely difficult to observe.

The egg-sacs are borne close to the abdomen and frequently extend quite beyond the end of the stylets. They usually contain from ten to twenty large dark eggs. The oviducts are of unusual interest in this species. While in all other species they terminate within the cephalothorax, in *C. phaleratus* they extend as a blind duct to the anterior border of the fourth abdominal segment (Pl. IV, fig. 1).

The following measurements of six females covering collections from the same spot during two years, give an average length of 1.73 mm.

No. 1	Total length	= 1.6
No. 2	" "	= 1.95
No. 3	" "	= 1.88
No. 4	" "	= 1.78
No. 5	" "	= 1.61
No. 6	" "	= 1.6

The males are only a little smaller—1.6 mm. being an average length for local specimens. The coloring of *C. phaleratus* is most brilliant. The ground-color, which in this species is directly in the chitin, is a brick-red. The second thoracic segment, the last abdominal segment, the stylets and the caudal setæ and spines, the swimming feet, the mouth parts, second antennæ, and the last segment of the first antennæ are sky-blue, which varies in intensity. Often these parts appear quite colorless. The egg-sacs are dark blue or lavender in the first stages of development.

C. phaleratus is a pelagic species. In aquaria it may often be found a little above the water line, where it sometimes crawls even beyond the upper margin of the meniscus line. Its swimming motion is a rapidly darting one. The easiest way of distinguishing it from all other members of the genus is by its superficial resemblance to the genus *Canthocamptus.* The short, eleven-jointed antennæ, and form of the rudimentary fifth feet, are certain microscopic points of identification.

This species seems to be very widely distributed in America, though nowhere is it particularly abundant. Forbes reports it from several localities in Illinois and Wisconsin and from Portage La Prairie, Manitoba. Marsh has found it in several of the Michigan lakes and Cragin reports it from Cambridge, Mass., as *Cyclops perarmatus.* Miss Byrnes has studied the species on Long Island, where she found it in "shallow, fresh-water ponds." I have noted it rather more abundantly in the spring collections, but *never* in great numbers from the vicinity of Haverford, Pa., and from a small spring-water pond near Gillette, Wyoming, as well as in collections from Lake Winnepesaukee and the vicinity of Cambridgè, Mass.

Subgenus PARACYCLOPS Claus.

Cyolops fimbriatus var. **poppei** Rehberg. Pl. IV, figs. 5-11.

Cyclops poppei Rehberg, '80, p. 550, Taf. VI, figs. 9–11.
Cyclops fimbriatus Schmeil, '91, pp. 35, 36.
Cyclops fimbriatus var. *poppei* Schmeil, '92, pp. 168–170, Taf. VII, figs. 14–16.
Cyclops fimbriatus Herrick, '95, pp. 121, 122, pl. XVII, figs. 8, 9; pl. XXI, fig. 11; pl. XXV, figs. 9–14.
Cyclops fimbriatus var. *poppei* Forbes, '97, pp. 63 and 65.
Cyclops fimbriatus Byrnes, '09, p. 33, pl. XV.

Synonymy and Distribution.—In his *Beiträge zur Kenntniss,* etc., of '91, Schmeil considered *Cyclops poppei* Rehberg, synonymous with the typical *C. fimbriatus.* The following year, however, after a more careful study of the species, though he still claimed the differences to be too few to warrant a new species, he granted that there should be a variety of *C. fimbriatus*, which he named *C. fimbriatus* var. *poppei* Rehberg.

All of Herrick's drawings of the stylets of what he describes as *C. fimbriatus* Fischer show that his specimens belonged to the var. *poppei*, and not to the typical form. Forbes recognizes the variety *poppei*, but gives no description or figures in connection with his note of the occurrence of the species. Miss Byrnes, following Herrick's mistake, has described this variety as the typical *C. fimbriatus* from Long Island. Her fig. 5, pl. XV, of the stylets with their characteristic armature of a longitudinal row of spines proves that the animal examined by her was not *fimbriatus*, but the variety *poppei* of Rehberg. There has been not a little confusion of the above-mentioned two forms. I cannot find a single description of the typical *C. fimbriatus* Fischer by any American investigator. The species seems to be represented in this country by the variety only. This has been described at least twice under the name of the type form.

Cyclops fimbriatus var. *poppei* seems to be one of the rarer species of the genus. Several of the investigators have failed to find it. Kofoid states in his *Plankton of the Illinois River*, "E. B. Forbes ('97) records in May, September, 1896, *C. varicans* Sars as common, and *C. fimbriatus* var. *poppei* Rehberg and *C. bicolor* Sars as rare." Forbes states that this is "a rare species in Manitoba, Alabama, and the north central States." Brewer does not record it from the waters about Lincoln, Nebraska. Marsh, in '95, names "*fimbriatus*" in his *Key to Species of Cyclops*, but gives no description. Miss Byrnes has studied the species from Long Island waters, where she states that "*Cyclops fimbriatus* has been taken in great numbers—especially in the collections made in the early spring." This observation agrees very closely with my own regarding the variety *poppei* in this vicinity. In a collection made in the spring (March) of 1907 it was the most abundant form. I have never recorded it from September to January. In February, 1909, I found a few egg-bearing females. I consider it one of the rarest of the members of the genus found in this locality.

Specific Description.—The somewhat slim cephalothorax (Pl. IV, fig. 5) tapers only slightly posteriorly. The first segment is half as long as the entire thorax. The dorso-ventral diameter is short in proportion to the length of the animal. In a specimen measuring 1.13 mm. it was but .14 mm. The width of the three posterior thoracic segments diminishes but a little. The lateral angles of the thoracic segments are not prominent. Both Herrick and Miss Byrnes have obviously drawn their specimens under pressure, when, as I have repeatedly observed, the thoracic outline is entirely changed. Fig. 5, Pl. IV, shows the form of cephalothorax in life. The third segment is finely serrated along its entire posterior margin (fig. 10, Pl. IV). These serrations often are slightly larger at the end of the marginal row. The fourth thoracic segment bears, laterally, a short row of minute but rather coarse "hairs" (fig. 11, Pl. IV). On the corresponding portions of the fifth segment there are present similar short rows of coarse hairs, but on this segment they are much larger (fig. 8, Pl. IV). The entire cephalothorax is to the abdomen as 7 : 5. Its length to its width is as 2 : 1.

The abdomen is wide, the first segment being but a little narrower than the fifth segment of the thorax. In my drawing of the living animal (fig. 5, Pl. IV) the first abdominal segment is foreshortened owing to the curve of the entire dorsal surface. This fact, taken together with the short first antennæ and the method of locomotion, suggests a strong resemblance to members of the genus *Canthocamptus.* The first three abdominal segments are finely serrate on their posterior margins. These serrations in the fourth segment, instead of stopping at the sides of the anal opening, turn anteriorly and extend a short distance along either side of this opening. There are, furthermore, between the upturned portion of the posterior row of serrations and the side of the anal opening, two very minute rows of what Schmeil calls "button-like projections" (fig. 6, Pl. IV). Neither Herrick's nor Miss Byrnes' drawings give an accurate view of this armature, though the former evidently noticed this detail from his fig. 11, Pl. 21, of his report of '95. Miss Byrnes' drawing shows the marginal row of serrations of the fourth abdominal segment extending across the anal opening. All the abdominal segments bear transverse rows of minute indentations of the form of the marginal serrations, but not projections of the cuticula. This may easily be proved by turning the animal on its side, when the dorsal and ventral lines of the abdominal segments will appear as unbroken lines. I find this character quite constant in specimens of the variety *poppei,* though Schmeil notes that it is often missing in the type *fimbriatus.*

The stylets (fig. 6, Pl. IV) differ from those of the typical *fimbriatus.* They are only as long as the last two abdominal segments. Their length is three times their width and their inner margins almost meet at the point of insertion in the abdomen. One of the main differences between this form and the type lies in the characteristic armature of the dorsal surface of the stylets. The lateral spine is inserted well towards the median line. On the outer lateral surfaces and a little below the position usually occupied by the lateral spine there is a row of prominent serrations. The position and course of this row of serrations may be seen in fig. 6 of Pl. IV. There are two well-developed apical setæ which are carried prominently divaricate. Of these two, the outer is a little over half as long as the inner and is ornamented on its outer surface with minute spines, its inner surface bearing the usual hairs. Herrick's statement, "inner two-thirds as long as the outer," is undoubtedly another case of reversed proportions. The longer seta is plumose. The delicate innermost setæ are as long as the outer and generally curved as in fig. 6, Pl. IV. The outermost setæ are very heavy, rather blunt and delicately plumose on their inner surface only. About the base of each there is a $\frac{3}{4}$ circle of long serrations.

The first antennæ of the female (fig. 7, Pl. IV) are eight-jointed. They are only half as long as the first thoracic segment and are carried at right angles to the median line, as is the case with practically all of the *Cyclopidæ.* The segments taper rapidly, the distal one being but one-quarter as wide as the first at its line of juncture with the second. The fourth segment is the longest. The two distal segments are slightly bent forward in life (fig. 5, Pl. IV). Herrick states: "The basal joint with a small semicircular series of fine bristles." This is not a characteristic of this species, but of the entire genus. Miss Byrnes' description is this: "The antennæ contain but eight segments; they are short and are characterized by two well-developed setæ." The fifth segment bears a well-developed sense-club (fig. 7, Pl. IV). This is somewhat different from Schmeil's figure of this organ for the type form. In the specimens that I have examined I find it to be rather more slim and spear-shaped than "club-shaped" as in the type. It suggests the form of the corresponding organ in *C. bicuspidatus* Claus (Pl. II, fig. 5). Many of the setæ of the first seven segments are delicately plumose, but those of the terminal segment are, as far as I have been able to observe, quite bare. Along the line of the distal third of the third segment (fig. 7, Pl. IV) I have repeatedly noted what appears to be the beginning of the segmentation of another antennal joint. However, I have never observed a specimen of "var. *poppei*" with nine-jointed first antennæ. The semicircle of fine bristles at the base of the first joint is unusually prominent.

The antennules are characterized by the two very short terminal segments.

The armature of the three-jointed swimming feet is as follows:

First pair—outer ramus, three spines, five setæ; inner ramus, one seta, one spine, four setæ.
Second pair—outer ramus, four spines, five setæ; inner ramus, one seta, one spine, four setæ.
Third pair—like the second pair.
Fourth pair—outer ramus, three spines, five setæ; inner ramus, one seta, two spines, two setæ.

The inner margins of all the branches of the swimming feet are ornamented with rows of bristles. This is especially the case in the second, third, and fourth pairs. In her description of the variations of this species, Miss Byrnes says: "The most striking variation in *C. fimbriatus* is a tendency toward a reduction in the armature of the inner ramus of the first swimming feet, where in the apical position, for example, a single large spine replaced two setæ or a spine and a seta, which is the typical armature of the organ." She does not give the "typical armature" in her table, and the small seta on the inner side of the inner ramus of the first pair of swimming feet she has probably overlooked.

The fifth foot (fig. 8, Pl. IV), which is one-jointed, I find bearing the following armature: On the inner side of the distal end of the single segment there is a heavy spine, serrate on its inner surface and finely but not densely plumose on its outer margin. The row of minute serrations which Schmeil shows to be present in the type form at the base of the corresponding spine (see his Taf. VII, fig. 12) I do not find at all after a careful examination of a number of specimens. There is a single spine-like projection at the base of the inner spine, but no indication of a row. On the outer distal corner of the fifth foot there is a very coarse spine-like seta that is densely plumose on its inner and outer side. These two "spines" (the outer is more nearly a spine than a seta) are of equal length. Between them and borne at the end of a button-like process is the middle seta, slightly longer than the two spines and plumose on its distal half. Rehberg noted that "das rudimentäre Füsschen ist mit zwei gleichlangen Dornen und einem kürzeren Haar besetzt, während sich bei *Cycl. fimbriatus* nur ein kurzer Dorn und zwei lange Haaren befinden." Schmeil admits that Rehberg's description and drawing is quite accurate, states, however, that the fifth feet in type and variety are identical. I am inclined to agree with Rehberg that the outer seta of the type form is replaced in his variety by a spine. There has been much confusion over this point. Herrick states that the fifth foot has "three spines." Miss Byrnes agrees in her description with Schmeil, for she finds "a coarse inner spine and two setæ." This is undoubtedly one of those details of structure which may vary considerably, and I merely give the observations of the investigators to show their opinions on this point.

The *receptaculum seminis* (fig. 4, Pl. IV) is of a very characteristic form. It consists of two portions. These are in the shape of long, closely lying narrow ellipses. The upper portion has a slight indentation in the middle of its anterior margin and the ends are slightly upturned. The porus is situated in the middle of the short common portion which connects the two divisions of this organ. The structure of the *receptaculum seminis* has never before been observed in the American representatives of this variety. The egg-sacs contain but a few dark ovæ, 7–10, and are carried close to the abdomen in life.

I have found that 1.17 mm. is an average length for females of the variety *poppei.* Schmeil gives .86 mm. and Herrick .8 mm. The former states that "die Varietät ist etwas kleiner als die typische Form." For the "typische Form" Schmeil gives for the female "0.92–1 mm." The smallest mature female that I have measured was 1.13 mm. long—longer than the typical European form. Schmeil's observations on the size of this species does not seem to hold good, then, for the American forms. In fact, the reverse is true of specimens from this vicinity. Further study of the species will undoubtedly show that type and variety are of a size.

The variety *poppei* is practically colorless. Irregular chains (fig. 5, Pl. IV) of rose-colored globules are scattered occasionally throughout both cephalothorax and abdomen, and the ovaries, when distended, appear a deep shade of lavender.

The most readily distinguished characters of this variety are the short eight-jointed antennæ (which show that it belongs either to the type or variety) and the very characteristic armature of the dorsal surfaces of the caudal stylets.

The following table illustrates the main points of difference between type and variety:

	C. fimbriatus Fischer.	*C. fimbriatus* var. *poppei* Rehberg.
(1) Fifth foot	with a spine and two setæ, the spine circled at its base by a row of minute spinules.	with two spines and a seta, one spine plumose, and no row of spinules at the base of either.
(2) Receptaculum seminis	"may reach the anterior border of first abdominal segment" (Schmeil).	narrow, low lying, ellipse (fig. 9, Pl. IV), with slight indentation in middle of anterior border.
(3) Fourth abdominal segment	serrations stop at side of anal opening.	serrations turn up (fig. 6, Pl. IV).
(4) Transverse row of serrations on stylets	form semicircle about stylets stopping above lateral spine.	extend longitudinally (fig. 6, Pl. IV).
(5) Stylets	narrow, set far apart, almost equal to last three abdominal segments.	shorter, inner margins almost meet, length equal to last two abdominal segments.

Schmeil notes further minute differences in the structure of the male first antennæ.

N. B.—Since the compilation of the above table I have had occasion to examine collections from Lake Winnepesaukee, N. H., in which a form occurs which bridges over the gap between type and variety as regards character No. 4. In these forms the transverse row of serrations on stylets is exactly as in the type form as figured by Schmeil, but the proportional length of stylets agrees with var. *poppei* and not with the type form.

LIST OF CYCLOPIDÆ RECORDED FROM A SINGLE SMALL POND IN THE VICINITY OF HAVERFORD, PA.

(The above small pond is on the estate of Mr. McFadden, directly on the south side of the Philadelphia and Western Railroad tracks and to the right of the bridge that crosses these tracks at Haverford station.)

Genus **CYCLOPS.**

I. Subgenus CYCLOPS Claus s. str.

1. **Cyclops viridis** var. **insectus** Forbes.

Not described in this paper, but an abundant form.

2. **Cyclops bicuspidatus** Claus.

II. Subgenus MACROCYCLOPS Claus.

3. **Cyclops fuscus** Jurine.
4. **Cyclops albidus** Jurine.

IV. Subgenus ORTHOCYCLOPS Forbes.

5. **Cyclops modestus** Herrick.

V. Subgenus MICROCYCLOPS Claus.

6. **Cyclops varicans** Sars.

VI. Subgenus EUCYCLOPS Claus.

7. **Cyclops serrulatus** Fischer.

Not described in this paper, but the most abundant form.

8. **Cyclops prasinus** Fischer.

VII. Subgenus PARACYCLOPS Claus.

9. **Cyclops phaleratus** Koch.

10. **Cyclops fimbriatus** var. **poppei** Rehberg.

In the above list, subgenus III is omitted since it only contains *C. ater* Herrick, a form not found thus far in this locality. This arrangement is taken directly from Forbes' paper of '97.

Description of *C. viridis* var. *insectus* Forbes and *C. serrulatus* Fischer are not given in this paper. The latter form is perhaps the commonest one of the genus and will not be mistaken for any other since no other American form approaches it in morphological details. Forbes has discussed the synonymy in his paper of '97, but since that time several European investigators have established new species and varieties all intimately related with the type form. A careful comparative study of these new forms will be necessary before the description of *C. serrulatus* Fischer can be brought up to date. It is known to be a most variable form. Size and stylet proportions are rarely constant in individuals taken at the same locality and even in the same collection.

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Explanation of Plates.

Plate I.—*Cyclops fuscus* Jurine. *Cyclops albidus* Jurine.

Fig. 1.—*C. fuscus,* adult female. Oc. 2, obj. 1. (Ocular and objective numbers refer to Leitz lenses unless otherwise noted. All drawings were made with the help of the camera lucida.)

Fig. 2.—*C. albidus*, adult female, showing the characteristic divaricate position of the egg-sacs. Oc. 1, obj. 1 (Bausch & Lomb).
Fig. 3.—Dorsal aspect of stylets and last abdominal segment of *C. fuscus*. Oc. 3, obj. 3.
Fig. 4.—Stylets and last abdominal segment of *C. albidus*. Oc. 1, obj. 3 (B. & L.).
Fig. 5.—Three proximal joints of the second female antenna, *C. fuscus*. Oc. 2, obj. 3.
Fig. 6.—Third and fourth joints of the second female antenna, *C. albidus*. Oc. 1, obj. 3 (B. & L.).
Fig. 7.—Terminal segment of first female antenna, *C. fuscus*, showing the typical deep serrations of the hyaline plate. Oc. 2, obj. 3.
Fig. 8.—Terminal segment of first female antenna, *C. albidus*. The finely serrated plate is characteristic. Oc. 3, obj. 5.
Fig. 9.—Twelfth segment of the first female antenna of *C. fuscus*, showing the armature of minute serrations and the sense-hair. Oc. 2, obj. 5.
Fig. 10.—Twelfth segment of the first antenna of a female *C. albidus*, showing rows of "thorns" and sense-club. Oc. 2, obj. 5.
Fig. 11.—*Receptaculum seminis* of *C. fuscus*. Oc. 3, obj. 3.
Fig. 12.—*Receptaculum seminis* of *C. albidus*. Oc. 3, obj. 3.
Fig. 13.—Fifth foot of *C. albidus*. Oc. 2, obj. 5.
Fig. 14.—Distal segment of the inner ramus of the fourth pair of swimming feet of *C. albidus*, showing a group of small hairs in place of the second seta of the inner side. Oc. 0, obj. 5.

PLATE II.—Figs. 1–5, *Cyclops bicuspidatus* Claus. Figs. 6–11 *Cyclops modestus*, Herrick.

Fig. 1.—An adult female (slightly extended by pressure). Oc. 0, obj. 3.
Fig. 2.—Lateral view of a stylet showing the minute serrations near the anterior end. Oc. 3, obj. 5.
Fig. 3.—The sense-club of the twelfth segment of the first female antennæ. Oc. 3, obj. 7.
Fig. 4.—A foot of the fifth pair. Oc. 3, obj. 7.
Fig. 5.—The *receptaculum seminis*. Oc. 3, obj. 3.
Fig. 6.—An adult female. Oc. 0, obj. 3.
Fig. 7.—An adult male with first antennæ folded under the cephalothorax. Oc. 0, obj. 3.
Fig. 8.—Stylets and last abdominal segment. Oc. 2, obj. 5.
Fig. 9.—A foot of the fifth pair. Oc. 1 (B. & L.), obj. 7.
Fig. 10.—Lamella of the third pair of swimming feet. Oc. 1 (B. & L.), obj. 5.
Fig. 11.—The three terminal joints of the first female antennæ showing hyaline plates and sense-hair. Oc. 1 (B. & L.), obj. 5.

PLATE III.—Figs. 1–5, *Cyclops prasinus* Fischer. Figs. 6–11, *Cyclops varicans* Sars.

Fig. 1.—An adult female. Oc. 2, obj. 3.
Fig. 2.—The stylets and last abdominal segment. Oc. 3, obj. 5.
Fig. 3.—The three terminal joints of the female first antenna showing the characteristic hyaline plates. Oc. 2, obj. 7.
Fig. 4.—The fifth foot. Oc. 2, obj. 7.
Fig. 5.—The *receptaculum seminis*. Oc. 3, obj. 5.
Fig. 6.—A mature female of *C. varicans* with eleven-jointed first antennæ: a winter transitional form. Oc. 2, obj. 3.
Fig. 7.—The stylets and last abdominal segment. Oc. 2, obj. 5.
Fig. 8.—An eleven-jointed antenna of the first pair in the female. Oc. 3, obj. 5.
Fig. 9.—The fifth thoracic segment showing the rudimentary fifth feet. Oc. 3, obj. 5.
Fig. 10.—The *receptaculum seminis*. Oc. 0, obj. 5.
Fig. 11.—A two-jointed swimming foot of the third pair. The division of the third joint is always indicated by minute rows of hairs. Oc. 2, obj. 5.

PLATE IV.—Figs. 1–4, *Cyclops phaleratus* Koch. Figs. 5–11, *Cyclops fimbriatus* var. *poppei* Rehberg.

Fig. 1.—An adult female. Oc. 0, obj. 3.

Fig. 2.—The stylets and last abdominal segment. Oc. 0, obj. 5.

Fig. 3.—The female first antenna. Oc. 2, obj. 5.

Fig. 4.—The fifth foot. Oc. 2, obj. 5.

Fig. 5.—An adult female; the first cephalothoracic segment appears somewhat foreshortened.

Fig. 6.—The stylets and last abdominal segment.

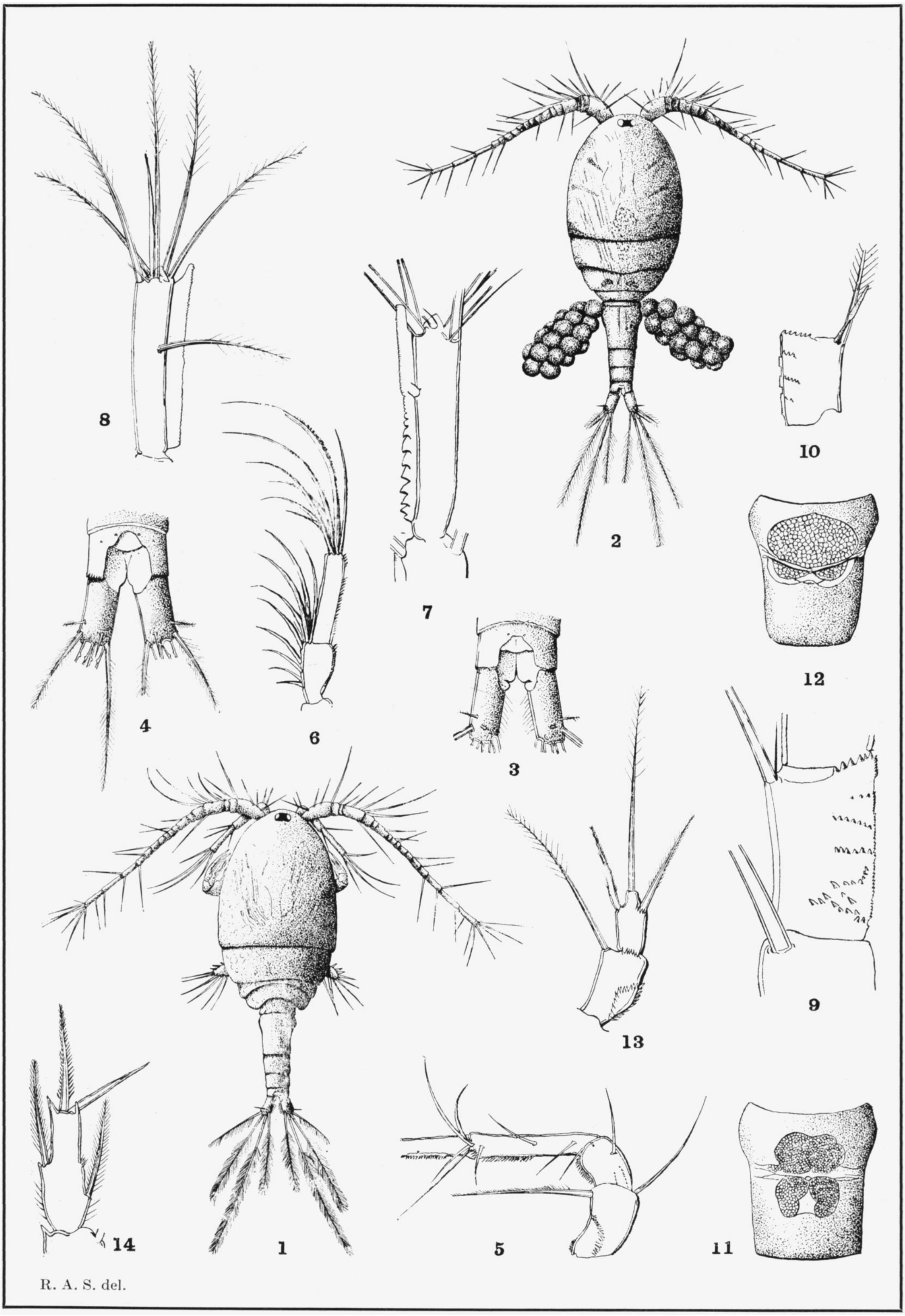
Fig. 7.—The female first antenna.

Fig. 8.—A foot of the fifth pair.

Fig. 9.—The *receptaculum seminis.*

Fig. 10.—Posterior serrated margin of the third thoracic segment.

Fig. 11.—Posterior margin of the fourth thoracic segment.



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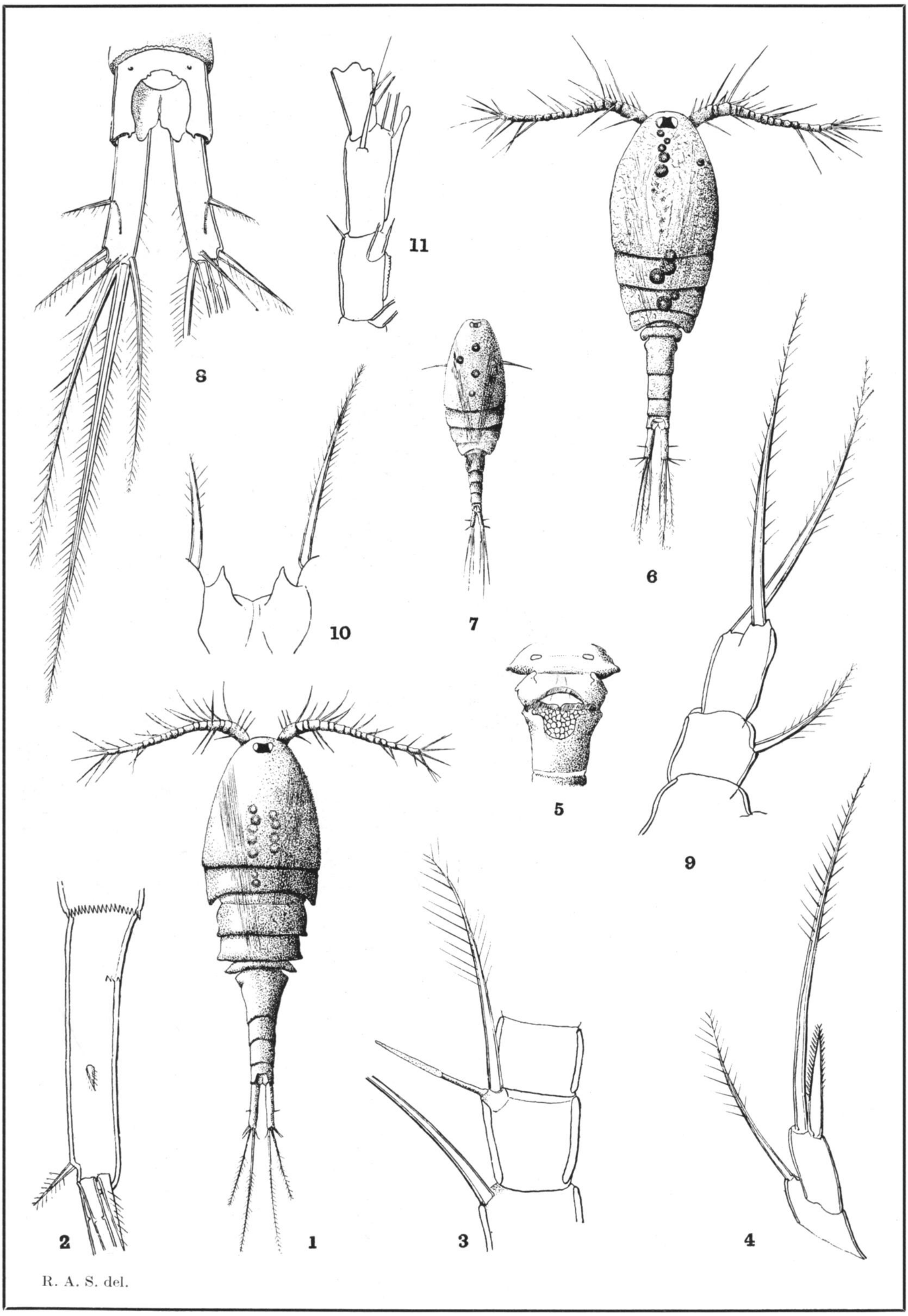

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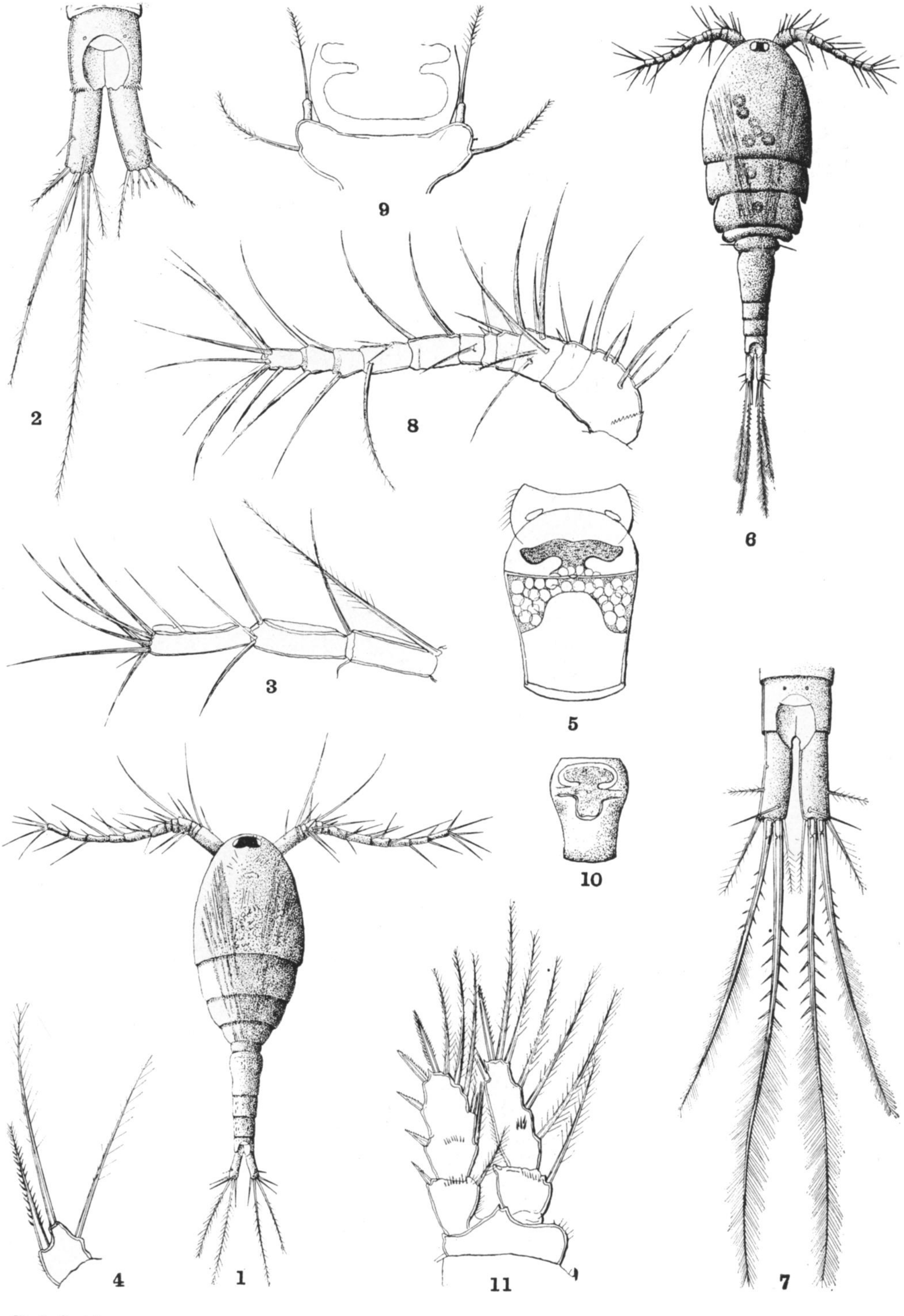

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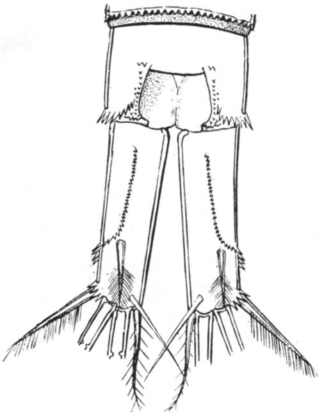

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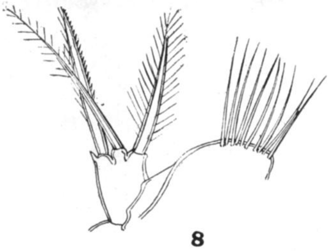

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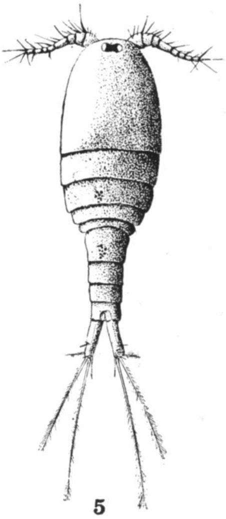

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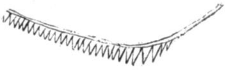

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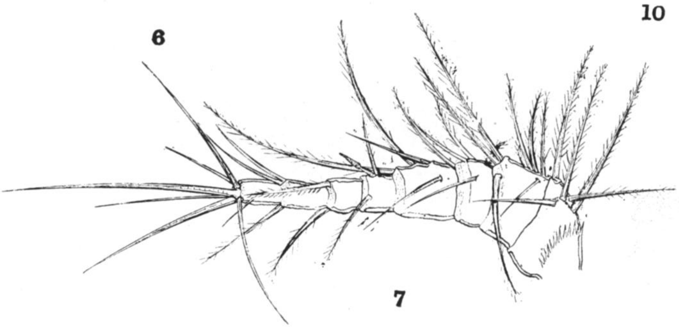

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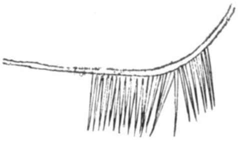

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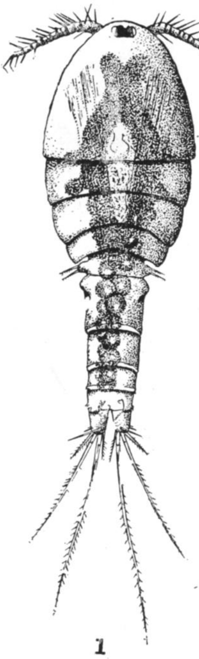

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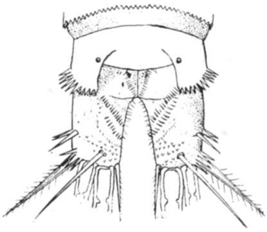

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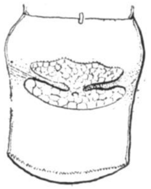

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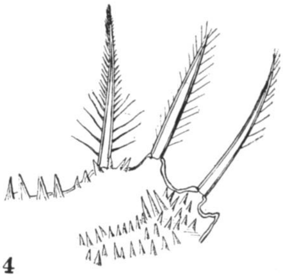

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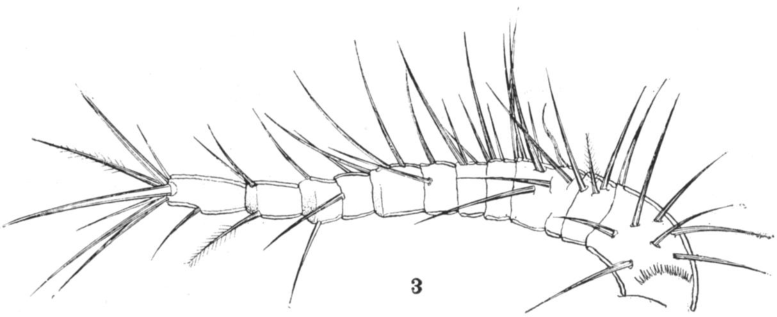

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